

JOURNAL OF THE SOCIETY OF MOTION PICTURE



AND TELEVISION ENGINEERS

Image Structure and Transfer Characteristics

Activities of Research Council

Color Analyzer

Studio Lighting Report

Stereoscopic Schlieren System

Intermediate Film TV System

TV Film Recording and Editing

Equipment for TV Programming

American Standards

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Image Gradation, Graininess and Sharpness in Television and Motion Picture Systems

Part I: Image Structure and Transfer Characteristics

By Otto H. Schade

The physical quality of motion picture and television images is determined by the transfer characteristic, the standard deviation or signal-to-fluctuation ratio, and the detail flux-response characteristics of the system. The performance of typical systems and system combinations is illustrated by examples permitting numerical comparison. The analysis of fluctuation levels ("noise") in photographic processes, based on sampling theory, includes an evaluation of the sine-wave frequency spectrum of the deviation as modified by the "aperture" processes of the system. The sine-wave response characteristics of typical apertures are developed as well as an accurate method of determining the equivalent "resolving aperture" (point image) of practical devices from sine-wave response measurements. A new system of rating image-forming devices is thus developed permitting precise evaluation and comparison of components as well as of complete systems including the eye. Part I discusses the transfer characteristics of motion picture and television systems. Parts II and III, to be published at a later date, will contain an analysis of signal-to-fluctuation ratios and detail contrast.

INTRODUCTION

THE QUALITY of images reproduced over a television or motion picture system may be judged by a visual comparison with respect to three characteristics: tone scale, graininess and sharpness. Such a comparison may indicate that one image is more grainy than the

other, has a longer or different tone scale, or has greater sharpness. These subjective impressions, however, are often difficult to separate. Differences in picture size, brightness, contrast and flicker, to mention only a few variables, may have a considerable effect on a visual evaluation of the image characteristics. The eye is not capable of performing a quantitative and objective analysis of image properties. It cannot, of course, be used at all to evaluate the quality of electrical images or image

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SYMBOLS

Note: Peak values are designated by a peak sign over the symbol, \hat{B} ; average values by a horizontal bar, \bar{B} ; and rms values by two vertical bars, $|B|$.

A	Picture area or frame area	K	Constant
B	Luminance (brightness)	n	Number of samples, light quanta, silver grains, etc., according to index
B_0	Luminance of "black" level	O	Operating point, (signals $x = 0$, $y = 0$)
C	Contrast range	q_e	Charge of one electron [Eq. (6)]
D	Total photographic density	q_0	Energy of one light quantum (see footnote on p. 141)
D^*	Density above fog and base density	S	Film speed
ΔD	Density increment or density range of photographic image	S_s	Photosensitivity, practical unit: microamperes/lumen
d	Object distance or viewing distance	x, y	Input and output signal values measured from 0 (general)
E	Exposure (unit: meter candle seconds) or voltage	$\dot{\gamma}$	Gamma at a point of an operating characteristic [see Eq. (10a)]
E_1, E_2	Exposure, index indicating order of process	δ	Diameter of a sampling or resolving aperture
$E_{1(a)}$	Exposure on first process determining "black" level	δ_s	Lens stop diameter
E_0	Bias voltage at "black" level	ϵ	Quantum efficiency (over-all)
F	Focal length of a lens	τ	Transmittance factor
g, G	Small- and large-signal transfer factors [Eqs. (8) and (9)]	ψ	Flux
I	Current		
I_0	Current set to black signal level at transmitter		

signals in intermediate stages of an imaging process, nor can it be used to evaluate or predict the effect of changes or improvements which are possible and are expected to occur upon further development of an imaging process. Television is a young and complex art with a large number of old and new variables. It will take some time to eliminate temporary defects and attain consistently the level of image quality of which the system is capable.

Various evaluations of the quality and particularly of the sharpness of television images have been reported in the literature. A careful subjective comparison of the relative sharpness of images transmitted over television channels with different passbands appears to be a most convincing and direct method of determining, for example, the loss of image sharpness caused by reducing a 4.25-mc (megacycles) television channel to 2.7 mc (present coaxial cables) or the gain in sharpness when the channel is increased to 6 or 8 mc.

The results of these tests, however,

depend to a great extent on the subject material, the source of image signals and the excellence of the system components. It is obvious that the reproduction of a subject which does not contain fine detail cannot be improved by providing a system capable of reproducing finer detail. A standard 35-mm motion picture film, when compared with the original scene, is certainly not a perfect source of image signals.

It is well known that duplication of a motion picture by a second motion picture process, identical with the original process, results in a marked degradation of detail signals and sharpness. Subjective observations in which a 35-mm motion picture is used as a source of image signals to evaluate a television process are, therefore, hardly conclusive. The inadequacy of such observations is particularly evident when the quality of the duplicating process approaches or exceeds that of the motion picture source, because even an ideal imaging process can but reproduce the quality of the signal source. Ten years ago 35-

mm motion picture film seemed adequate for television tests as a source of picture signals. Film scanners were then ahead of direct-viewing cameras in quality but still inferior to the motion picture. In subsequent years, however, the resolution obtainable with camera tubes and kinescopes has increased considerably. This increase has been obtained in a large measure by providing better operating conditions for the tubes. The resolution of the standard 35-mm motion picture was soon exceeded in laboratory tests and larger, sharper test patterns and even better lenses are required to test the image sharpness obtainable with a standard television channel of 4.25 mc. It is, therefore, desirable and necessary to employ objective methods and a unified approach in an analysis of image quality to coordinate and compare the charac-

teristics of optical, electrical, photographic, and visual processes. When the photographic process is used as a link in a television process it is to be expected that the photographic process must be adapted to the characteristics of the television process and its imaging quality may then, by itself, be quite unsuitable for direct observation by eye.

The principles for an objective evaluation of image quality have been discussed in an earlier paper.¹ An evaluation of practical systems and system combinations, such as in television recording, requires an analysis of existing processes in greater detail. The transfer characteristics, relative fluctuation levels (grain and noise), and the detail signal response (resolution, detail contrast) of the various system components and their combinations will, therefore, be treated in that order.

A. IMAGE STRUCTURE AND THE SAMPLING PRINCIPLE

A common basis for an analysis of image quality is indicated by the fact that all images have a structure. When an apparently uniform area is examined under sufficient magnification, at least theoretically, it is found to consist of particles or groups of particles arranged in a regular or a random fashion. The particles or groups are, to use a general term, "samples" of energy or matter which, according to number, arrangement and size, determine the image quality. The imaging process is fundamentally a sampling process. The light flux from a scene, the image flux passing through a lens, the electron currents in television tubes or amplifiers, are a flow of discrete samples. Samples of light energy, known as "quanta" of light, are emitted from points of an object. A small fraction of these samples is collected and directed by the camera lens to form an instantaneous image of the light distribution at the object. The degree of continuity in the image information is obviously dependent on the number of samples; with respect to an

area, continuity depends on the sample density.

In practical processes the optical image is formed on a photosensitive material which releases photoelectrons when it is bombarded by light quanta. This sample-conversion process generally reduces the number of samples, but it permits their accumulation and storage. In the television process the electrical samples can be stored directly as a "charge image." In the photographic process the photoelectrons combine with silver ions in a secondary conversion process to form submicroscopic silver samples, which, in turn, can be accumulated and stored as a "latent image." Following these processes, which take place upon "exposure" of a light-sensitive surface, are processes of multiplication or "development" in which the electron energy or the mass of the silver sample is increased by large factors to become sufficient for the transmission of information and the control of light sources for image reproduction.

1. Continuity, Sample Number and Sample Size

The energy or mass of the original sample is increased by supplying and attaching to it a group of "secondary" electrons or atoms, thus forming a new sample unit. If a sample is visualized as a three-dimensional particle, it can be seen that the original sample may be enlarged in one dimension (height, intensity) but still retain its original cross section; or, it may be enlarged in two or three dimensions and thus increase in cross section. In a three-dimensional development (film) the increase in sample size must be limited because it introduces an error in sample position.* In all cases, however, the development must be uniform for all samples. The optimum value of the sample size depends on a number of factors to be determined later. The sampling process gives, in principle, a discontinuous picture information. Continuity and uniformity of an area are, in a strict sense, illusions. These illusions depend on restricting variations in sample density in an area representing a constant level to a threshold value, a certain small deviation determined by the method of observation. It is not difficult to see that deviations in density become larger when the sample number per unit area decreases, and that restoration of continuity requires, then, a process of filling out the spaces between samples and a supply of additional samples. It is logical to attach these additional samples in equal numbers to the original sample units thus expanding the size of the unit representing one original sample. This process obviously does not supply new information, but rather causes a fusion of possible detail in areas equal to or larger in diameter than the spacing between original sample centers. The desired uniformity requires in most cases overlapping of the expanded areas.

* The silver speck forms on the outside of a bromide crystal.

2. Integration of Samples by Low-Pass Filters (Apertures)

A device limiting the observation or transmission of detail or fluctuations in one dimension (time) by fusing and integrating all faster fluctuations is known electrically as a "low-pass filter." A similar optical device spreading light samples in two dimensions (over a small area) when point sources of light are imaged, is an "aperture." It is well known that the shape and area of the point image made with a pinhole camera are controlled by the size and shape of the pinhole aperture. The point image itself may be identified as the "sampling aperture" of the imaging device. *The sample aggregate or figure of confusion formed by an imaging device and representing a mathematical point is thus defined, in general, as the "sampling aperture" in the image, and the effect on image definition and limiting resolution is an "aperture effect" or a two-dimensional low-pass filter effect.* Because of their resolution limit, lenses, dot or grain structures, mosaics and the eye are two-dimensional low-pass filters which integrate samples within areas equal to their sampling aperture. It is, therefore, unnecessary for an image-reproducing process to integrate a dot or line structure which cannot be resolved by the eye, nor is it necessary to reproduce detail which cannot be seen by the eye in the final image. The characteristics of vision as a sampling process are thus needed as a standard of comparison.

Two-dimensional images are an assembly of point images produced simultaneously (lenses, printing, etc.), or in sequence (facsimile, television) by moving one sampling aperture over the image area. Uniform coverage is obtained with one aperture by "scanning" the image area along parallel paths (lines), the aperture moving at a constant velocity in the "horizontal" direction along the scanning line and progressing stepwise by constant increments in the "vertical" direction. In this manner two-

dimensional information under the scanning aperture is translated into one-dimensional information: a signal current varying in intensity with time. The change in dimensions indicates a quadratic relation between the diameter (and resolution) of the scanning aperture as a two-dimensional filter and the passband of an electrical channel. It likewise indicates a change of units and quadratic rules for combining optical and electrical "aperture" effects.¹

The foregoing discussion has shown the similarity of elements and functions which must be performed by an imaging system. Before specific characteristics are treated, it will be of interest to discuss a number of general relationships which are readily understood from the sampling principle and must be satisfied before images of a given quality can be produced.

3. Light Energy, Image Quality and Image Size

The image quality is controlled basically by the energy levels obtainable in the imaging process. The higher the useful level of energy and the larger the number of samples, the higher can be the image quality obtainable by the process. A given image quality is, therefore, characterized by: (1) the total number of sample aggregates in the image frame; (2) the relative accuracy of sample density and location in the frame with respect to the original; and (3) the size of the sample aggregate with respect to the frame size. Hence, when the distribution and the total number of samples in the frame area of a television image or a photographic image are held constant and the sample size or sizes are expanded or contracted in proportion to the frame size, the quality of the image remains constant and is independent of the frame size. Not only does the quality remain constant but it is also obtainable with the same scene illumination, depth of field and exposure time by maintaining a proper relation among the

optical parameters. These relations may be illustrated by examining the photographic process.

It is known that the photosensitivity of the primary process in photographic film is, in principle, independent of the grain size built into a particular film type. To make one grain developable, certain numbers of light quanta, photoelectrons, and silver atoms are required whether the grain is large or small. The ratio of the number of grains developed in an area to the total number of light quanta received by the area is the over-all "quantum efficiency" of the film process (including development).^{*} This quantum efficiency can be determined from the normal sensitometric curves of density, D , as a function of exposures, $\log E$, and a grain count.

The light flux of one meter candle per second, $E = 1$, of white light represents the quantities:

$$1 \text{ lm/sq m} = n_o q_o/\text{sq m} = 1.3 \times 10^{16} \text{ quanta}^\dagger/\text{sq m}$$

The number, n_o , of light quanta, q_o , incident on 1 sq mm of film surface during exposure time is, therefore:

$$n_o/\text{sq mm} = 1.3 \times 10^{16} E$$

(E in meter-candle seconds) (1)

The number, n_s , of silver grains obtained with a given value E , depends on the spectral response and the degree of development, γ , of the film and is given by:

$$n_s/\text{sq mm} = n D^* \quad (2)$$

where D^* is the film density above the densities of "fog" level and film base, and n is the number of equivalent grains at $D^* = 1$ for the particular film type.

^{*} It is apparent that the spacing between developable centers is an important factor.

[†] This number is the number of quanta in the wavelength range, $\lambda = 0.40$ to 0.73μ from a black body at 5400 K, which would give one lumen. Radiation outside this range is excluded because it contributes nothing to the luminous output.

The effective quantum efficiency, ϵ , is, therefore:

$$\epsilon = n_s/n_o = n D^*/E \cdot 1.3 \times 10^{10} \quad (3)$$

The quantum efficiency of film has its highest value in the toe region of the transfer characteristic, $D = f(\log E)$, and decreases for larger values of D or E . The total light is given by the number of grains in the image frame multiplied by the quantum efficiency; in conventional units it is the exposure multiplied by the film area, A (in square meters):

$$\text{Light energy} = E A \text{ lm sec} \quad (4)$$

For a constant grain number and quality, the light energy must remain constant when film and grain areas are shrunk or expanded in proportion. The exposure, E , will thus change in inverse proportion to the frame area, A ; and the film speed, $S = K/E$, will change in direct proportion to the frame area. (K is a constant.)

An analysis of the optical parameters for the exposure of the film furnishes the following facts. If a distribution of the light flux emitted from object points according to Lambert's law is assumed, the quantum efficiency of the camera lens is expressed by the ratio of image flux, ψ_i , to object flux, ψ_o , and given by:

$$\psi_i/\psi_o = \tau(\delta_s/2d)^2 \quad (5)$$

for the practical condition, $d \gg \delta_s$, where τ is the transmission factor of the lens, δ_s , the stop diameter, and d , the object distance. For a given angle of view and object distance the "depth of focus" is a geometric factor controlled by the lens stop diameter, δ_s . The requirements of a constant quantum input [Eq. (4)] and depth of focus are thus fulfilled by a constant lens stop diameter, δ_s , independent of the size of the image formed by the lens. The focal length, F , of the lens must be changed in proportion to the image diagonal or the square root of the area to maintain the viewing angle, $F \propto A^{1/2}$; and the f /number of the lens, therefore, also changes as the square root of the image frame area, A . Finally, the lens resolution in lines per millimeter must change in proportion to $1/A^{1/2}$, i.e., it must be inversely proportional to the f /number, which is theoretically true. The relations of the various parameters for constant image quality are summarized in Table I.

A given image quality (including depth of focus) requires a certain lens-stop diameter and a scene illumination which is determined by the quantum efficiency of the film process. The image quality is theoretically independent of the size of the image as long as the relations in Table I can be fulfilled. The diffraction of light sets a lower limit to the f /number at $f/0.5$ for refractive

Table I. Requirements for Constant Image Quality in a Frame Size of Area A .

Image Properties		Lens Properties		Photosensitive Surface and Signal Development	
Light flux	= constant	Focal length	$\propto A^{1/2}$	Quantum efficiency	= constant
Graininess	= constant	Lens diameter	= constant	Conversion efficiency (Signal development)	= constant
Tone range	= constant	f /number	$\propto A^{1/2}$	Sample number and distribution (grain)	= constant
Sharpness	= constant	Resolution	$\propto 1/A^{1/2}$	Sample diameter	$\propto A^{1/2}$
Viewing angle	= constant			Resolution	$\propto 1/A^{1/2}$
Depth of field	= constant			Gamma	= constant
				Speed rating	$\propto 1/A$

lenses. The smallest practical frame dimension, however, is limited to larger values by mechanical tolerances, difficulties in design and correction of lenses, and difficulties in the manufacture of films having adequate grain sizes, distribution and uniformity.

The question whether a 16-mm motion picture film process can be equal in quality to a 35-mm process for identical lighting conditions has in principle, been answered in the affirmative. It remains to be shown by analysis whether lenses and film of adequate characteristics are available.

The relations given in Table I are valid also for the television process.

The fundamental independence of picture quality and image size is demonstrated by a variety of kinescope and camera-tube sizes. Mechanical tolerances, insulation problems, heat dissipation, grain sizes, current densities and other technological difficulties impose limits on the size reduction of practical tubes. The fact that television images utilize a single image surface to generate or reproduce "live" images introduces a number of difficulties which are not found in motion picture systems. The screen of a small kinescope for theater projection, for example, must be capable of dissipating continuously the total input power. A motion picture frame, on the other hand, is exposed to the projector light flux and heat for only $\frac{1}{24}$ sec. Small defects or dust particles on a camera-tube surface are permanently visible and present a serious problem; similar defects in each frame of a projected motion picture can hardly be noticed for statistical reasons.

A simple comparison of the film process with the electrical process of television can be misleading in various respects because of differences in the low-pass filter response or "aperture response" of an electrical channel which must be considered when the requirements for equal performance are evaluated.

To equal the quality of a 35-mm motion picture negative a television camera tube such as the *image orthicon* must be capable of converting light quanta into useful electrons with an equal over-all quantum efficiency. Operation with a light range in the order of 30 to 1 reduces the electron storage in the tube from its short-range value of unity by a factor of approximately 2 in the low-light range. Absorption of photoelectrons by a mesh electrode and the addition of a fluctuation level from an electron-discharge beam, which may be likened to a high "fog" level, require a further increase of 3 to 1 in exposure. To compensate for these inefficiencies, the primary quantum efficiency of the photocathode of the tube must be in the order of 6 times the over-all efficiency of the film process. A primary quantum efficiency of 100% means that one electron charge, q_e , is emitted by one light quantum.* With the electron charge

$$q_e = 1.6 \times 10^{-19} \text{ coulombs} \quad (6)$$

a quantum efficiency of 100% results in a photocurrent:

$$I = 1.3 \times 10^{16} q_e = 2080 \mu\text{a/lm} \quad (7)$$

The quantum efficiency of 1% is, hence, obtained with a photocathode sensitivity, $S_e \approx 20 \mu\text{a/lm}$.

When this quantum-efficiency value is divided by six to obtain the equivalent over-all quantum efficiency of an image orthicon with $S_e = 20 \mu\text{a/lm}$, the result is 0.16%. This value is in the same order as that of the fastest film types with normal development. Photosensitivities equal to and higher than the above value are obtained consistently in commercial tubes and there is evidence that much higher values will be obtained in the future.²

* The spacing factor does not appear in this conversion because the photocathode of the image orthicon is a continuous photosensitive surface.

B. TRANSFER CHARACTERISTICS

1. Transfer Factors and Gamma

The relation of "sample" numbers or sample densities of the output and input flux of an imaging device or system is described by transfer characteristics. A truthful and undistorted reproduction of light values by an imaging process requires that the intensities and ratios between light values in the object be duplicated in the image. The corresponding over-all transfer characteristic in linear coordinates is a straight line; the system response is linear. This ideal performance can be obtained by a combination of components having linear or nonlinear transfer characteristics. In practical processes the transfer of large light ranges is limited at the low-light end of the range by fluctuations due to lack of samples or by a light "bias." At the high-light end of the range it is limited by saturation effects because of limitations in the sample supply or storage capacity of system components.

The graphic representation of transfer characteristics in linear or logarithmic coordinates is a useful step in evaluating and combining their properties. The transfer characteristics of electron tubes are usually plotted in a linear-coordinate system which is convenient for evaluat-

ing the effects of constant additive or subtractive levels, "biasing" potentials or currents, rectification effects, distortion, and the transfer factors (signal ratios) for large and small signals.

The nonlinearity of the characteristics encountered in image "transducers" such as photographic film, television camera tubes and kinescopes are particularly evident when the characteristics are plotted in linear coordinates, as shown in Fig. 1. In many cases a signal-conversion process has a transfer characteristic following a law of diminishing returns such as an exponential characteristic or a power law, $y = x^\gamma$, where the exponent, γ , is smaller than unity. Either of these characteristics may be modified by secondary effects to produce characteristics of the type shown in Fig. 2, and exemplified by the eye, photographic film (density, D , versus exposure, E , in Fig. 1), the iconoscope, and image orthicon. It is evident that characteristics of this type can cover a larger range of input-signal energy with a given sample number and storage capacitance than a linear characteristic. The "compression" and the transfer of incremental signals by fewer samples requires, however, a subsequent

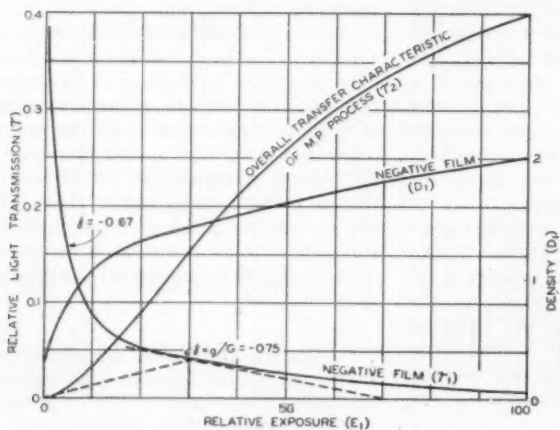


Fig. 1. Photographic transfer characteristics in linear coordinates.

re-expansion of signal or light values by a transfer characteristic with a higher exponent ($\gamma > 1$, see Fig. 3) in order to restore over-all linearity. (Compare curve of M.P. process in Fig. 1.) A good balance of gradation values depends on maintaining the ratio, g/G , of the incremental signal transfer factor

$$g = dy/dx \quad (8)$$

to the large signal transfer factor

$$G = y/x \quad (9)$$

substantially constant over the transmitted light range. The signal values, x and y , are measured from the operating point O .*

A plot of an operating characteristic for unidirectional signals in logarithmic coordinates will, of course, never show the operating point, O , which is located at the origin of the coordinates.

It is readily shown that the transfer ratio, g/G , is equal to the exponent, γ , when the operating characteristics are expressed as a power law. When

plotted in logarithmic coordinates, the slope, $d(\log y)/d(\log x)$, of the characteristic is equal to the transfer ratio, g/G , because

$$d(\log y) = \frac{1}{y} \log_{10} y$$

$$d(\log x) = \frac{1}{x} \log_{10} x$$

and

$$\frac{d(\log y)}{d(\log x)} = \frac{dy/y}{dx/x} = g/G \quad (10)$$

for the condition that the operating point is the origin of the coordinate system.

In photographic terminology the maximum slope of the film transfer characteristic, $D = f(\log E)$, has been termed the "gamma" of the film. The slope or gradient at any point may be defined as the point gamma, γ . Because of the identity, $D = -\log \tau$ (τ = transmittance), the point gamma equals the log-log slope:

$$\gamma = d(-\log \tau)/d(\log E) \quad (11)$$

It is, therefore, suggested that Eq. (10) be adopted as a general definition of the point gamma, i.e., for the condition $x = 0, y = 0$ at the operating point O :

$$\frac{d(\log y)}{d(\log x)} = \frac{dy/y}{dx/x} = g/G = \gamma \quad (10a)$$

This definition agrees in every respect with Equation (11) and requires that the operating point O , be placed always at the origin of the coordinate system. The point gamma, γ , of a sensitometric-film curve can thus be obtained from a linear plot of the transmittance characteristic, $\tau = f(E)$, shown in Fig. 1, by determining the transfer ratio, $g/G = -\frac{(d\tau)E}{(dE)\tau}$, or from a logarithmic plot as the slope $d(\log - \tau)/d(\log E)$.* These

* It is well known in electron-tube engineering that the operating point can be located by an electrical bias anywhere on the transfer characteristic of an amplifier stage without transmitting the d-c component at the operating point. For unidirectional signals the operating point of an electronic amplifier normally does not coincide with minimum signal values but with the average values of the signal unless a d-c restorer or black-level setting circuit is used. The operating point of photoelectric or electrooptical transducers such as camera tubes or kinescopes cannot be moved along their static transfer characteristic because it is impossible to eliminate a steady light bias, $x_{(0)}$ or $y_{(0)}$, which remains as a minimum exposure, $E_{(0)}$, or as a luminance, $B_{(0)}$, in the optical input or output signals. In these cases, the operating point, O , can be moved only along the electrical coordinate (y -axis (I) for camera tubes, x -axis (E) for kinescopes), the optical coordinate of the operating point remaining at zero value.

* It is noted that the gamma of a negative or positive film is a negative quantity, while a reversal film has a positive gamma. In use the sign is usually neglected.

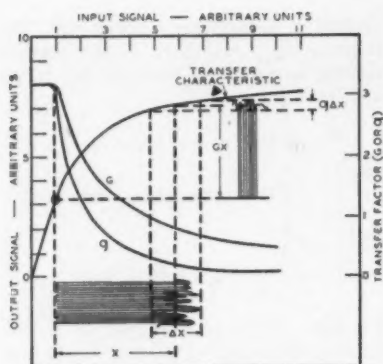


Fig. 2. Signal compression due to transfer characteristic following power law with exponent less than unity.

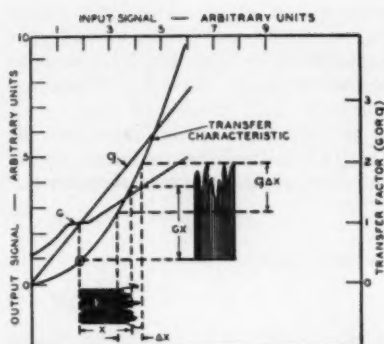


Fig. 3. Signal expansion due to transfer characteristic following power law with exponent greater than unity.

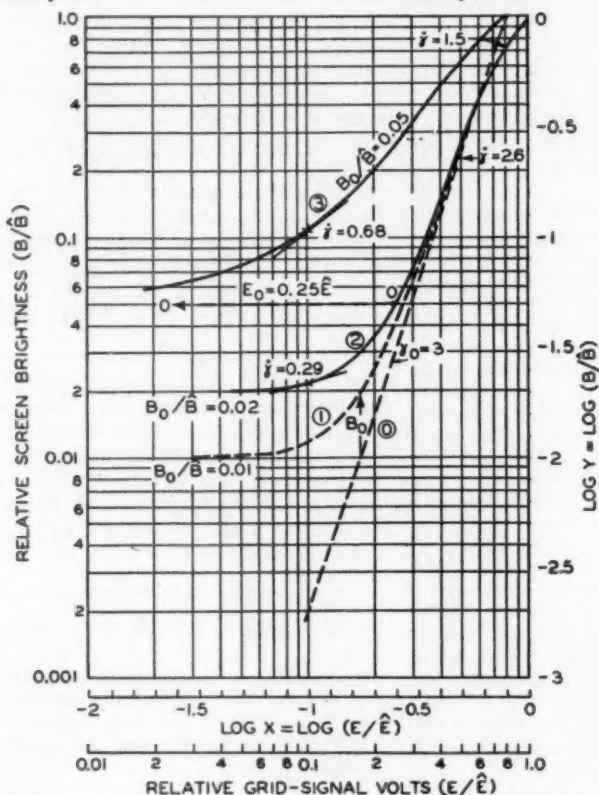


Fig. 4. Effect of additive or subtractive constants on point gamma of kinescope transfer characteristics.

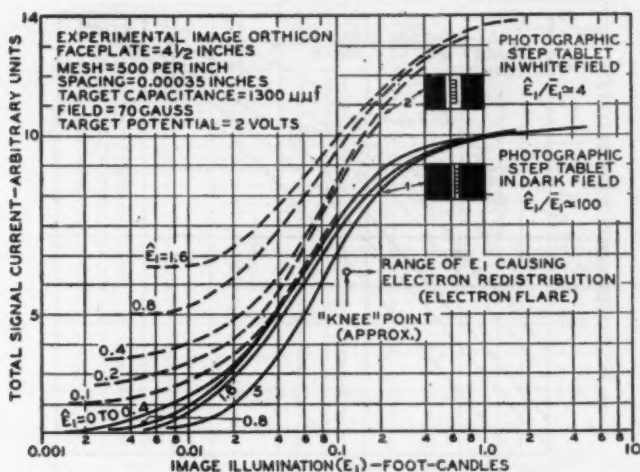


Fig. 5. Dynamic transfer characteristics of an image orthicon containing d-c signal components.

methods of determining the point gamma apply to all types of transfer characteristics. Additive signal constants, such as a superimposed light bias, B_o , on a film or a kinescope screen alter the value, G , the shape of the characteristic curve in log-log coordinates and, hence, γ .

The effect of additive or subtractive signal constants on the point gamma may be demonstrated on the kinescope transfer characteristic shown in Fig. 4. The theoretical electrical characteristic, O , of the kinescope has a gamma of three. Due to phosphor saturation or loss of current in electron guns, the gamma, γ , of the high-light curve section is reduced. Scattered light or ambient illumination represents an additive signal constant, B_o , in the order of 1 to 2% which, when added to all B -values, produces the *dynamic characteristics* (curves 1 and 2) having a toe.

In certain cases (television recording) it is desirable to increase the gamma in the low-light range. The grid-bias voltage for zero signal is then moved

above the cutoff value by a voltage bias, E_o . This displacement of the operating point along the x -signal coordinate requires that the characteristic be redrawn by subtracting E_o from all signal values to furnish the *operating characteristic* curve 3. The light bias, B_o , however, which is caused by E_o , cannot be subtracted and remains in the optical output signal. The increase of γ due to E_o in the low-light range is obvious from the drawing.

2. Transfer Characteristics of Television Camera Tubes

A family of *image-orthicon* transfer characteristics¹ plotted in semilogarithmic coordinates and containing d-c components caused by optical and electron "flare" is shown in Fig. 5. Measurements with various image-orthicon types have shown that the shape of the transfer characteristics is determined by the operating mechanism of this type. The characteristics of different tubes differ, therefore, mainly in the numerical values of the scales. These differences are determined by the target capacitance

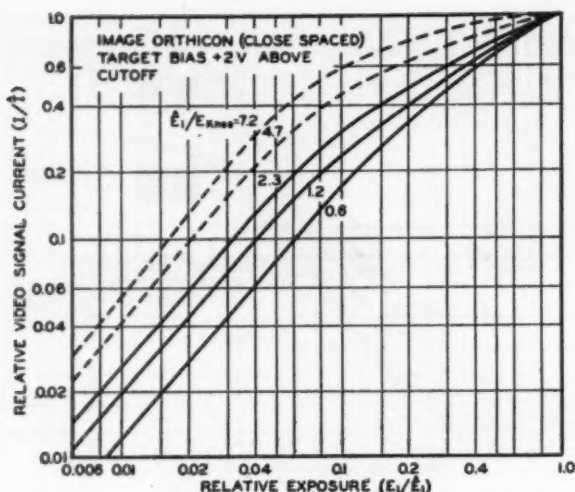


Fig. 6. Dynamic transfer characteristics of close-spaced image orthicons.

secondary-emission ratios, and photo-sensitivity of the particular type. In normal operation the "flare"-current or d-c black-level current, I_o , is subtracted by setting the video black-level signals to zero. The resultant transfer characteristics, letting $I_o = 0$, redrawn in logarithmic coordinates (Fig. 6), are typical dynamic operating characteristics for the image orthicon.* The dashed curves represent the condition of over-exposure which produces undesirable edge effects.

The change of gamma in the transfer characteristics of television camera tubes with increased exposure comes from two causes: (1) diminishing collection of secondary electrons (photoelectrons in the iconoscope) from high-potential target areas; and (2) scattering of the uncollected electrons or of flare light over a portion of or the entire target area.

* The relative exposure is specified by the ratio of the high-light exposure, E_1 , to the exposure, E_{knee} , where the high-light values are located at the shoulder or "knee" of the transfer characteristic.

The first effect is desirable and similar to the expedients used for obtaining low-gamma film characteristics, i.e., incomplete development. The second effect, light- and electron-flare, is undesirable as it may introduce edge effects, level variations and a threshold for low-light values. Electron "flare" in image orthicons can be particularly undesirable because of its nonuniform distribution.

The d-c black-level current, I_o , increases with exposure because of optical and electron "flare." The "black" signal level is, therefore, actually a gray signal value (see Fig. 5) but may be reset at the transmitter to a perfect black signal value by subtracting the d-c signal component. The signal range which can be seen on the kinescope screen depends, of course, on the kinescope brightness range and the over-all gamma of the system.

The changes in the gamma of the camera-tube characteristics obtained by varying the exposure are shown in Fig. 7. A high exposure (broken-line curves in Fig. 6) reduces the gamma in the high-

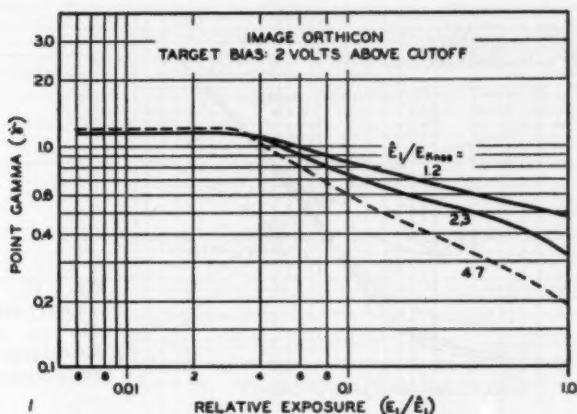


Fig. 7. Point gamma of transfer characteristics given in Fig. 6.

Figs. 8 a,b and 9 a,b are on plate pages 170 and 171.

lights and increases electron redistribution which causes strong local flare and distortion of black levels, overemphasizes edges and defects, and coarsens fine gradations. (See Figs. 8a and 8b.) A lower normal exposure (curve 1.2 or 2.3, Fig. 6) has a finer natural tone scale and if desired can be corrected electrically to a lower gamma. (See Figs. 9a and 9b.) These characteristics are duplicated by the commercial image-orthicon types³ with 3-in. face plates.

Rendition of gradation in fine detail (texture) requires a low level of random fluctuations and spurious signals, and good but not overemphasized resolution. It is well known that spurious detail signals such as those caused by dust particles, small scratches, or a collector mesh structure go unnoticed in larger storage surfaces (films, targets) but can cause considerable difficulty in small image surfaces because of the high magnification on the final viewing screen. A larger target surface results in higher resolution and better texture because of the reduction of defects and mesh structure in proportion to image size. It

also results in a lower fluctuation level because of increased storage capacitance. A larger target surface can be combined with a small optical image on the photocathode of the image orthicon by electrical image magnification. (The effect of a mesh structure will be discussed further under resolution.)

The dynamic transfer characteristics of the *iconoscope* are shown in Fig. 10 and are replotted in log-log coordinates in Fig. 11. These characteristics may again be regarded as typical when scalar values are considered as relative values which may vary for different tubes and tube sizes (1848 or 1850). As in the image orthicon, the combined effect of optical and electron flare (redistribution of electrons) causes the fundamental effect of raising the black-level signal, although the d-c level signal is normally not transmitted. Because of the fairly uniform distribution of the flare light and "flare-electrons" over the target, the black-level current depends more accurately on the average illumination, \bar{E}_1 of the image surface. Subtraction of the d-c level signals, I_d , furnishes the

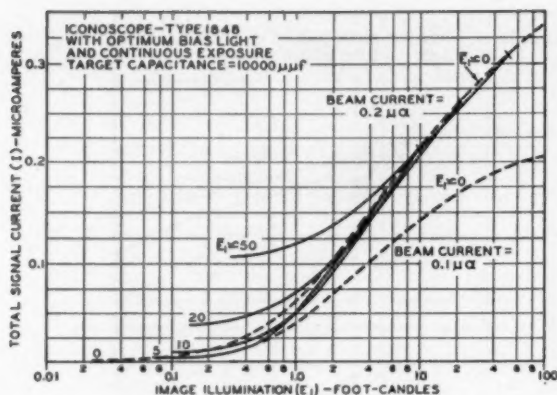


Fig. 10. Dynamic transfer characteristics of iconoscope containing d-c signal component.

operating characteristics such as $\bar{E}_1 = 5$; $I_o = 0.01$ in Fig. 11.

Although desirable in its effect of increasing the exposure latitude of the camera tube, the mechanism of incomplete electron collection and subsequent redistribution can cause excessive flare and nonuniform levels (shading, dark spot).

The *orthicon* is a camera tube having a linear transfer characteristic ($\gamma = 1$) and is free of redistribution effects. The linear relation of signal current and exposure, however, requires operation with high charges and large currents to accommodate the highlights in normal scenes. In practical designs difficulties in maintaining adequate resolution with high-beam currents limit the maximum useful storage capacitance and seriously impair the "signal-to-noise" ratio in the medium- and low-light region of the kinescope image when the system is corrected to approach a linear over-all transfer characteristic (discussed in Part II).

Storage camera tubes with substantially linear response such as the *orthicon*, the British C.P.S. Emitron, and certain types of *Vidicons*² (an *orthicon* type with photoconductive target) have, therefore, a short exposure latitude requiring low-contrast scene lighting, sub-

dued highlights and critical control of camera-tube exposure.

An analysis of fluctuation levels in television images (Part II) points out that a natural and constant gamma in the charge storage mechanism of the order of $\gamma = 0.5$ (not by redistribution) overcomes the above limitations; the tube operation remains within the boundaries of practical signal development by electron beams. The characteristics of such a camera tube are, therefore, of interest for comparison with commercial tube types. Its transfer characteristic in log-log coordinates is a straight line with the constant slope, $\gamma = 0.5$.*

The operating characteristics of camera tubes are sections of the dynamic transfer characteristic extending upward from a minimum exposure value, $E_{1(o)}$ and corresponding video signal current I_o . The zero point of the operating characteristic is, therefore, a function of the scene contrast range. The value, $E_{1(o)}$, depends further on the interpretation by the camera operator. His

* The author was informed some time ago by Dr. A. Rose of the RCA Laboratories at Princeton, that one-half power-law transfer characteristics could be obtained with photoconductive targets.

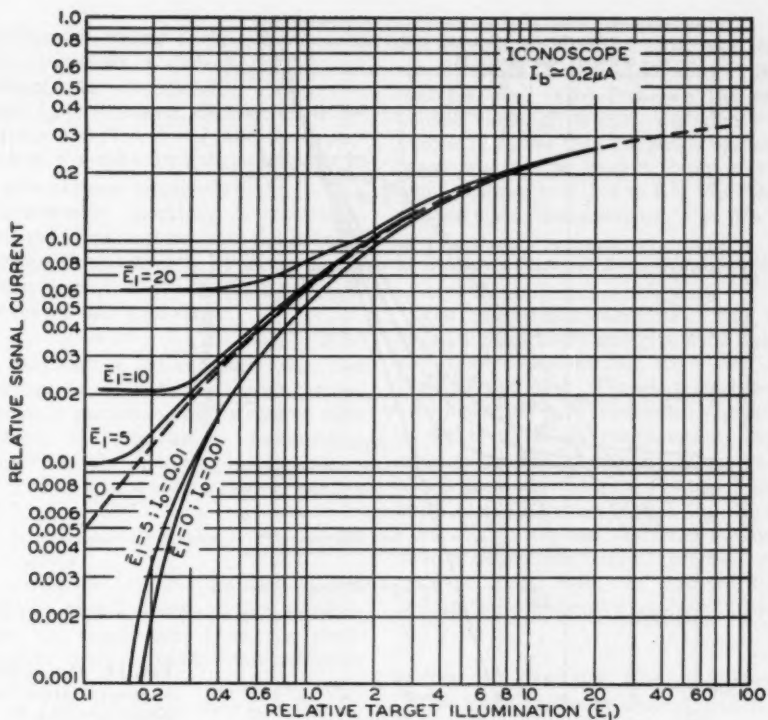


Fig. 11. Iconoscope transfer characteristics of Fig. 10 replotted in log-log coordinates.

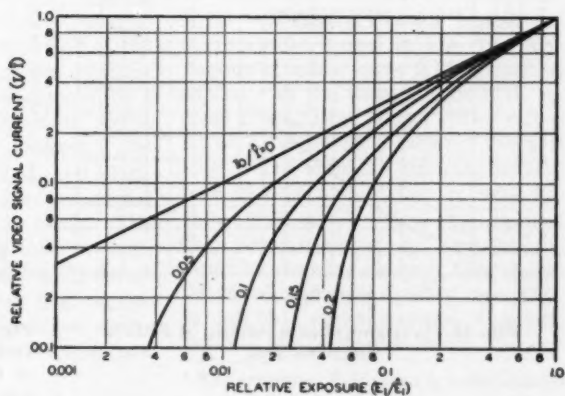


Fig. 12. Operating characteristics of camera tube having a transfer characteristic following a one-half power law.

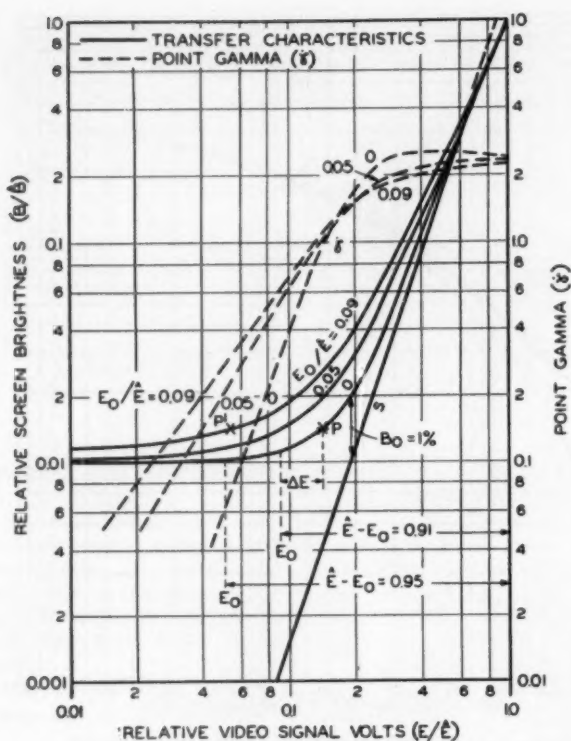


Fig. 13. Operating characteristics and point gamma of kinescope.

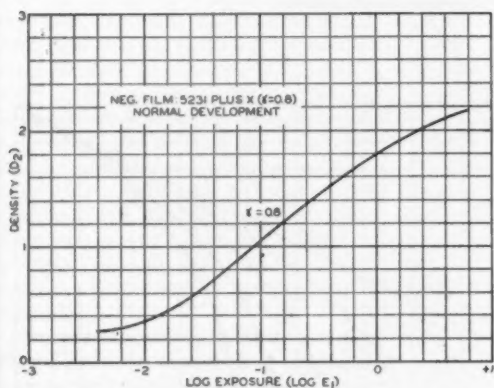


Fig. 14. Transfer characteristic of Plus X negative film.

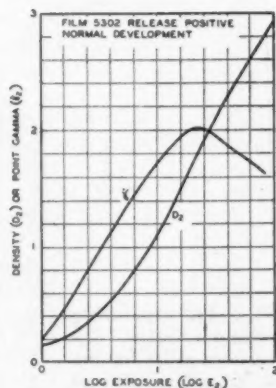


Fig. 15. Transfer characteristic and point gamma of fine-grain release positive film.

decision of letting a certain exposure, E_{10} , represent a "black level," and setting the corresponding video current, I_0 , to zero level, corresponds to the subtraction $I' = I - I_0$, and the expansion of this value by gain adjustment to a normal signal amplitude by $1/(\hat{I} - I_0)$. Camera-tube operating characteristics are, therefore, derived from the primary dynamic characteristic by changing the video current, I , at any given value, E , to the operating current:

$$I' = (I - I_0)/(\hat{I} - I_0) \quad (12a)$$

A reduction of the exposure range and setting, $I_0 = 0$, causes, hence, an increase in gamma, γ_1 , of the camera-tube transfer characteristic as illustrated in Fig. 12 by the operating characteristics of a camera tube with a normal gamma of 0.5.

3. Kinescope Operating Characteristics

Kinescope dynamic transfer characteristics obtained with picture modulation are constructed from the static transfer curve S (taken from published technical data for kinescope types in the *RCA Tube Handbook*) shown in Fig. 13, by adding the flare and ambient light bias, B_0 , which is determined by optical conditions in tube and viewing room. A maximum measured screen contrast range, $C = 100$, for example, in a normal image furnishes $B_0 = 0.01\hat{B}$ and the dynamic characteristic curve 0 in Fig. 13. The operating characteristic of the kinescope is a section of the dynamic characteristic and can be adjusted to a variety of values by the black signal level setting, E_0 , at the receiver. The conditions, $E_0/\hat{E} = 0.05$ and 0.09 , shown in Fig. 13, represent zero-signal settings close to subjective black. The corresponding operating characteristics are constructed by expanding the signal range, $\hat{E} - E_0$, of curve 0 to unity. The signal voltage E' for these corresponding operating characteristics are determined from:

$$E' = (\hat{E} - E_0)/(\hat{E} - E_0) \quad (12b)$$

For the range, $E_0/\hat{E} = 0.09$, and the signal voltage, $E = 0.14$ at point P , for example, Eq. (12b) furnishes the expanded value, $E' = 0.055$ for point P' . Figure 13 shows that kinescope operating characteristics have a lower maximum gamma, $\hat{\gamma} = 2.2$ to 2.3 , than the original static characteristic, $\hat{\gamma} = 3$.

4. Motion Picture Film Characteristics

The transfer characteristics of Plus X negative film (5231) and type 5302 fine-grain release positive film are shown in Figs. 14 and 15.* The characteristics were measured with substantially parallel light on II B sensitometer step exposures. The developed films obtained from the Motion Picture Film Dept. of the Eastman Kodak Co., New York, N.Y., received standard motion picture processing (spray process on negative, deep tank on positive by DeLuxe Film Laboratories, New York, N.Y.).

5. Over-All Transfer Characteristics

The combination of several transfer characteristics in an imaging system results in a curved or S-shaped over-all characteristic. The characteristics of an image orthicon (Fig. 6) ($I_0 = 0$) in combination with a linear amplifier and the kinescope transfer characteristics, $E_0/\hat{E} = 0.05$, of Fig. 13 furnish the curve family shown in Fig. 16. The parameter in this curve is the high-light exposure in the camera tube with respect to its "knee point." The values 1.2 to 7.2 represent a range of five lens stops. The optimum exposure for best tone quality and texture is near the value $\hat{E}_1/E_{knee} = 2$ (see Figs. 9a and 9b). Overexposures, 4.7 and higher, result in excessive electron flare (redistribution) and poor quality (see Figs. 8a and 8b); underexposures, 1 or less, result in loss of shadow detail.

* The exposure, E , is given in meter-candle seconds.

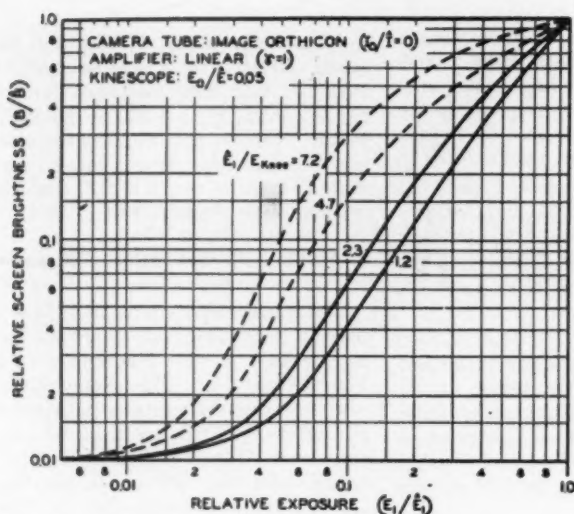


Fig. 16. Over-all transfer characteristics of a television system.

Adjustment of the black-level setting, E_o , at the kinescope changes its transfer characteristic (see Fig. 13) and, consequently, the gamma of the over-all transfer characteristic. The characteristics obtained with linear amplifiers and with the kinescope black-level setting, E_o/\bar{E} , as parameter are shown in Fig. 17 by the broken-line curves for an image signal source with linear transfer characteristic, $\gamma_1 = 1$, such as a light-spot scanner or orthicon (or British C.P.S. Emitron), and by the solid curves for normal exposure of an image orthicon. The characteristics for the linear signal source are identical with the kinescope operating characteristic and, because of the high gamma, $\gamma_{12} \approx 2.2$, seriously compress tone rendition of scenes exceeding a 10 to 1 contrast range (blocked "blacks"). The image orthicon characteristics are much more acceptable because they permit reproduction of a scene having a contrast range of 40 to 1 with an over-all gamma of approximately 1.3 decreasing in the highlight and shadow tones. A natural-tone rendition (constant gamma) requires, therefore, a correction of the

transfer characteristic. More specifically, reproduction of a scene having a contrast range of 100 to 1 and constant gamma requires an over-all gamma of unity.

The characteristic of a standard motion picture film process is shown in Fig. 18. The film characteristic, 0, is slightly S-shaped and the over-all system characteristic, curve 1 or 2, becomes more S-shaped because of the flare light bias from camera- and projection-lenses ($\frac{1}{2}\%$ for each) and the light bias due to ambient light on the projection screen (1%). A combination and a repetition of uncorrected television and motion picture processes result in a more serious compression of both shadow and highlight gradation as exemplified by the combination characteristics in Fig. 19.

It is evident that a normal projected 35-mm motion picture is not an ideal source for generating television signals and neither is it, as is well known, a good source for making a duplicate motion picture. It is common knowledge that a chain of separate amplifiers can remain linear with respect to trans-

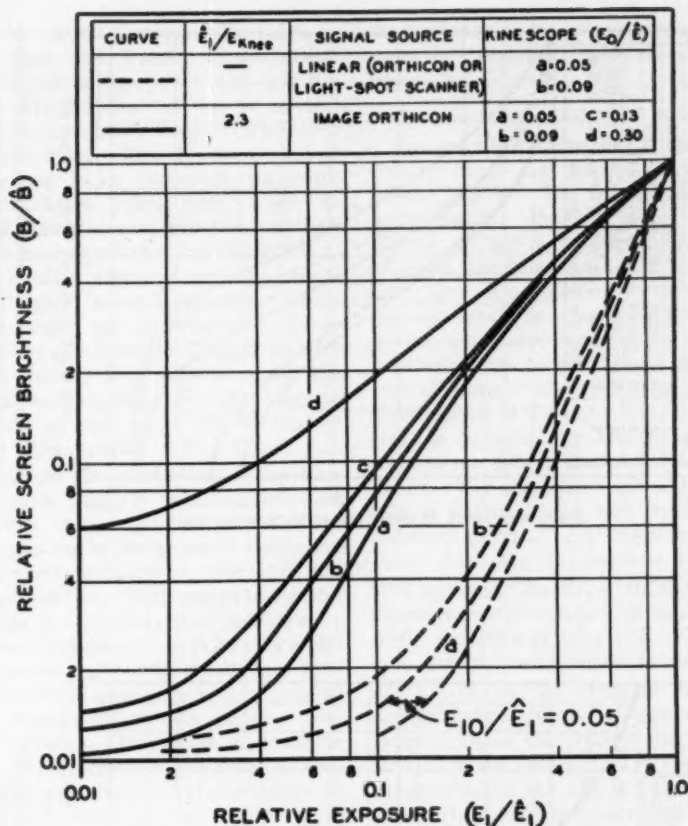


Fig. 17. Over-all transfer characteristics of television systems with image orthicon and linear signal sources.

fer and frequency characteristics when each amplifier has linear response characteristics. Such amplifiers can be cascaded without loss of quality. By the same principle, imaging processes with linear response characteristics can be cascaded without loss of quality. It is possible to correct errors in the frequency response and transfer characteristics, but the image signals must remain considerably above the fluctuation or "noise" level at all points of the system after passing through lenses, films, television tubes and amplifiers.

6. Transfer Characteristics and Gamma of Motion Picture Film for TV

The reproduction of images over a motion picture and television process involves a large number of transfer elements. Shape and contrast range of the transfer characteristic of a normal motion picture positive are adjusted to fit the optical conditions in direct theater projection. It is logical, therefore, that the characteristics of motion picture film intended as a picture source for reproduction by a television system or for storage and reproduction

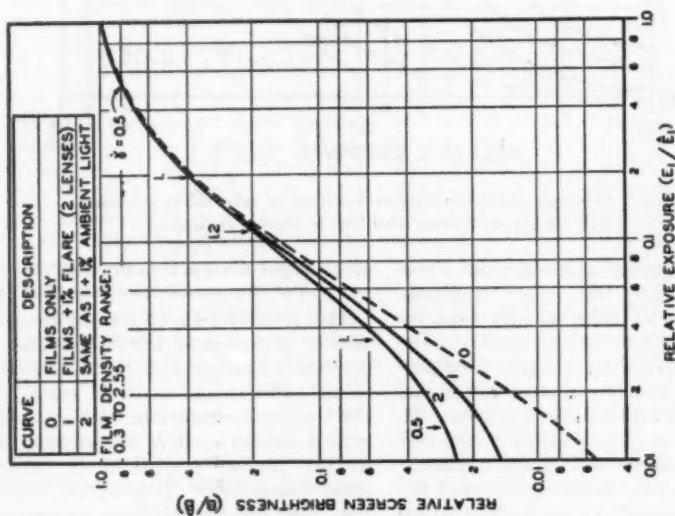


Fig. 18. Transfer characteristic of 35-mm motion picture process.

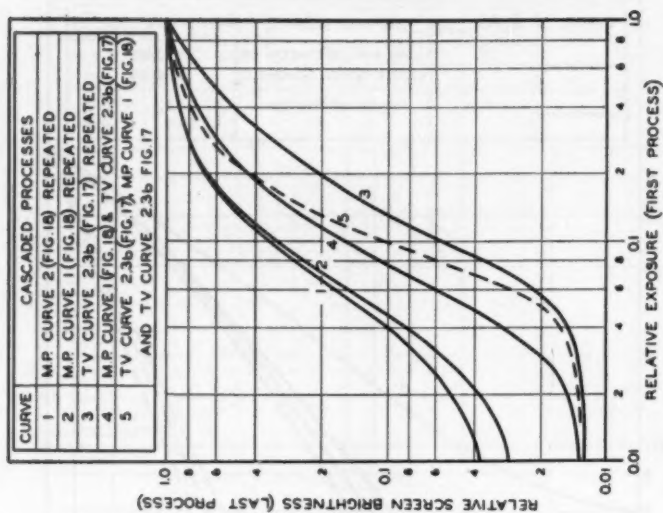


Fig. 19. Transfer characteristics of normal (uncorrected) imaging processes in cascade.

of video signals should be adjusted to fit the range and transfer characteristic of the television system and not the eye. The addition of one or several imaging processes increases the need for low distortion. The television process introduces as an important parameter an adjustable "black level" which, in effect, permits a subtraction of light levels and eliminates high densities in the positive film as a requirement. The "signal" levels in the system (contrast range) can be reduced to lower values to gain linearity of signal transfer as in electron tube amplifiers, but the signal must remain sufficiently large to prevent an increase of the fluctuation level (noise, treated in Part II).

The excessive distortion of the tone scale (see Fig. 19) resulting from an addition or a repetition of "normal" processes can be prevented by restricting the operating range on tube and film characteristics. With regard to the film process it is evident that operation in the constant-gamma sections of the film transfer characteristics results in uncritical exposure conditions and in over-all film characteristics with unity or constant gamma. Inspection of available film characteristics shows that the constant-gamma range of positive films in particular extends over hardly more than a 20 to 1 range in transmission. It is very desirable that films with a

shorter toe and a longer constant-gamma range be developed for television purposes.

7. Motion Picture Film for Television

The graphic solution for the optimum density range and gamma of motion picture positive film for television is quite simple. Because it is advantageous to use a substantially linear amplifier, the density range of the positive film (controlled by the print gamma) should be adjusted to equal the optimum exposure range of the camera tube which can be determined from the over-all transfer characteristics such as those shown in Fig. 17. The exposure scale is adjusted by adding or subtracting a constant, E_{10} , to the exposure values. The constant is selected to obtain a characteristic with reasonably constant gamma. An image orthicon (curve 2.3a, Fig. 17) requires an additive constant, $E_{10}/\bar{E}_1 = 0.03$, i.e., an exposure contraction to a 25 to 1 range, while an orthicon type (Fig. 17), will give a more constant gamma with $E_{10}/\bar{E}_1 = 0.05$ and an exposure range of approximately 10 to 1. The density range, ΔD_2 , in the positive film should thus have the values $\Delta D_2 \approx 1.4$ for an image orthicon and $\Delta D_2 = 1$ for a linear camera tube such as the orthicon. Desirable motion picture film characteristics are shown in Table II.

Table II. Desirable Characteristics of Motion Picture Film for Television.

	Camera Tube			Remarks
	Iconoscope	Image Orthicon	Orthicon	
Camera exposure range	30 to 1	25 to 1	10 to 1	Linear amplifier
Positive Film				Constant gamma, short toe
Density range ΔD_2	1.6	1.4	1	Between shoulder and toe
Approximate gamma (γ_2) for negative $\Delta D_1 = 1.25$	1.28	1.12	0.8	for $\gamma_1 = 0.68$
for negative $\Delta D_1 = 0.95$	1.7	1.47	1.05	Exposure range of neg. 100:1 30:1

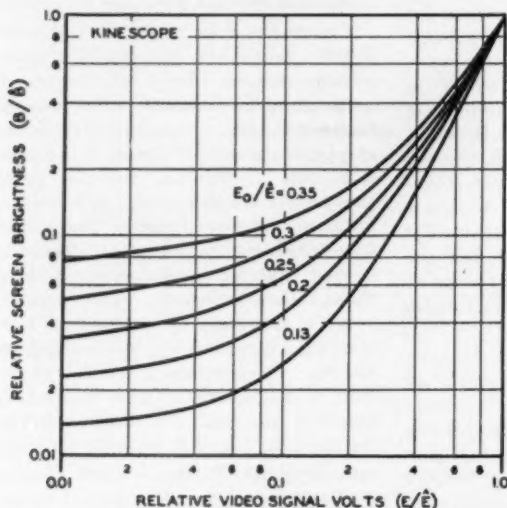


Fig. 21. Operating characteristics of kinescope with restricted signal range.

It is obvious that the specified density range, ΔD_s , in the positive print requires adjustment of the print gamma, γ_s , which depends on the density range of the negative which, in turn, is a function of negative exposure and brightness range in the camera image (100 to 1 and 30 to 1 for $\gamma_1 = 0.68$ in Table II). A 35-mm print of the SMPTE Television Test Negative on 5365 stock developed to a gamma of 0.95 gave excellent uniformity of levels and negligible "flare" when projected into an orthicon or image orthicon. The reproductions of the gray scale and tone values in the picture section were excellent (Fig. 20),* required no black expansion, and were far superior to those obtained with a normal high-gamma test film. Due to absence of distortion in the constant-gamma positive, however, black-level and signal range varied in accordance with variations in density and range in the nega-

tive, exceeding at times the exposure range of the orthicon. Reproduction of the film by an image orthicon with moderate exposure ($\bar{E}_1/\bar{E}_{knes} = 1.2$) gave, therefore, the best results. The appearance of an optical projection of the low-gamma print is, of course, quite unsatisfactory.

The process of kinescope recording is, in principle, a process for storing and duplicating a video signal. Assuming a constant-gamma transfer of light values by the film process, it follows that the combination transfer characteristic of the recording kinescope, the film-scanning camera tube, and the video amplifier must likewise have a constant gamma to obtain an undistorted duplication of the original video signal. It has been shown that the adjustment of the operating point, E_s , on the kinescope characteristic is a means of varying contrast range and gamma of the kinescope and results in a family of characteristics shown in Fig. 21. The exposure range

* The arc line in the picture is a target flow in the camera tube.

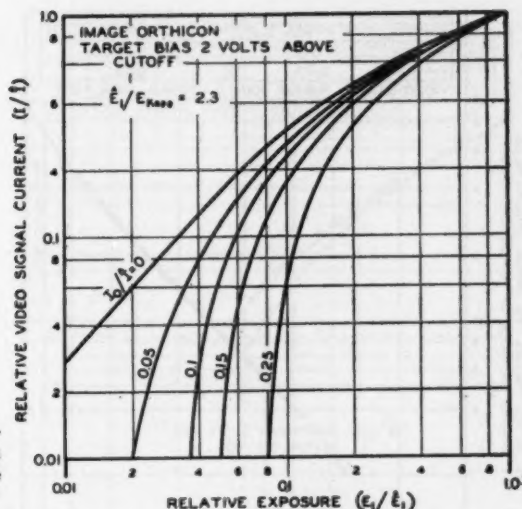


Fig. 22. Operating characteristics of image orthicon with restricted exposure range.

of the film and the following camera tube can thus be restricted to any desired value.

The light level representing zero video signal at the kinescope is a gray level on the positive film and results in a (d-c) signal-current level on the camera-tube characteristic below which the video signal will never decrease. This minimum signal level, I_0 , represents, therefore, the black level in the video signal, and is set to zero at the transmitter by an operator adjustment. Restriction of the exposure range and resetting of the black level by subtraction of the minimum signal, I_0 , from the transfer characteristic of the camera tube furnishes the family of operating characteristics as shown in Fig. 12 or as in Fig. 22 for an *image orthicon*. The method of constructing these characteristics has been explained above (see Eq. 12a).

After the curve families are plotted, the light range giving the best match of kinescope and camera-tube operating characteristics can be determined by rotating one of the curve sheets 180° around its diagonal and placing it over the other curves so that the scales for

light values and electrical signal scales superimpose. For the example, the curves coinciding most accurately in shape are the kinescope curve, $E_s/\hat{E} = 0.3$, and the camera-tube curve, $I_s/\hat{I} = 0.1$. (It is permissible to twist* the coordinates slightly.) When equal video signal values are selected, the corresponding light values on the two characteristics plotted against each other furnish the required transfer characteristic for the motion picture process (Fig. 23), assuming that a linear video amplifier is used. Film characteristics approaching this characteristic can now be selected. For uncritical exposure conditions and processing, both negative and positive films should be developed to approximately equal and constant gammas. It will be shown in Part II that a higher negative gamma and short toes reduce the fluctuation (noise) level in the film process. The remaining error in the film transfer characteristics is to be eliminated by correcting the transfer characteristic of the video amplifier

* The angle of twist indicates the departure from unity gamma in the associated photographic process.

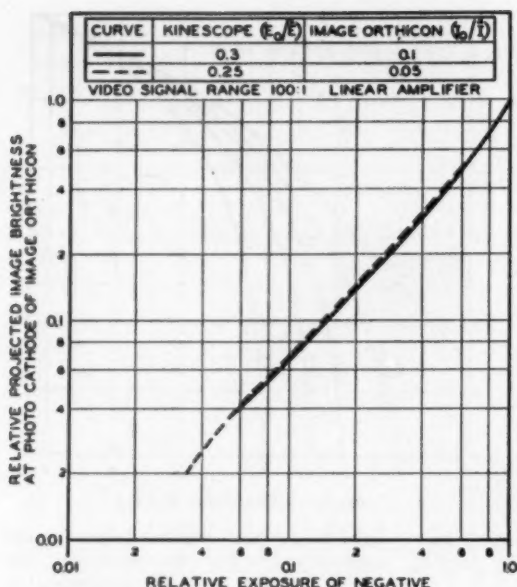


Fig. 23. Over-all transfer characteristic of motion picture process for reproduction of television recording with image orthicon.

preceding the kinescope or following the camera tube or both. Depending on the position in the chain (video signal-amplifier-kinescope-film process-camera tube-amplifier-video signal), the video correction characteristics differ. Correction of the amplifier driving the recording kinescope, for example, assumes that the video signal output values on the camera-tube characteristic and the video-input signals to the kinescope amplifier are equal. The amplifier output signal is thus found by tracing the camera signal over the light values in the film and kinescope characteristics back to the kinescope grid signal which equals the amplifier output signal. An electrical correction following the film process is more practical and has the advantage that the final image is under direct visual observation, permitting instantaneous adjustments for best results.

When an iconoscope is used as a film scanner the best compromise match of characteristics is obtained for $E_s/\hat{E} \approx$

0.3 at the kinescope and an averaged peak illumination, \hat{E}_1 , in the order of 10 units (in Fig. 11) at the iconoscope mosaic. The gamma in the high-light range of the iconoscope, however, is too low, requiring considerable "white" expansion by a correction amplifier. This condition is amplified at higher peak exposures of the tube for which the kinescope bias decreases toward $E_s/\hat{E} = 0.2$. The operating conditions for a linear film scanner (orthicon, light-spot scanner) are evaluated similarly and furnish the transfer characteristics shown in Figs. 24a and 24b. The film characteristics are listed in Table III. Film characteristics for a camera tube with constant gamma, $\gamma_1 = 0.5$, are listed for comparison.

8. Effect of the Line Raster on Film Exposure and Sensitometry

Maximum detail contrast in kinescope images requires a scanning-beam diameter smaller than the pitch distance of the scanning or "raster" lines. (See

Fig. 24a. Over-all transfer characteristic of motion picture process for reproduction of television recording with linear camera tube.

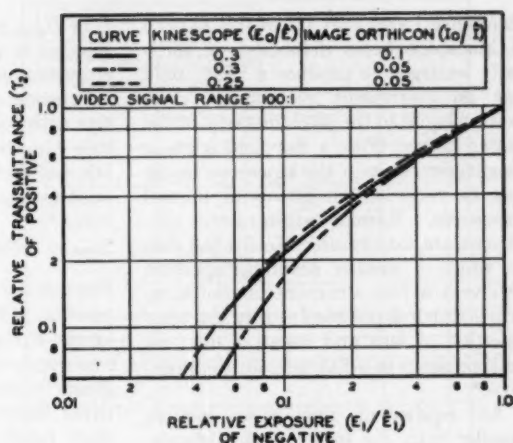


Fig. 24b. Transfer characteristics of film process and amplifier used in process of Fig. 24a.

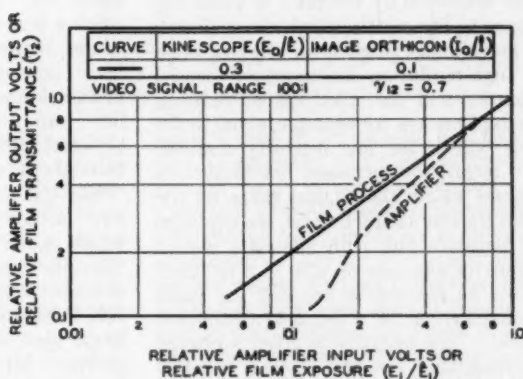


Table III. Characteristics of Motion Picture Film For Video Recording.

	Camera Tube $\gamma_1 = 0.5$	Iconoscope	Image Orthicon	Orthicon $\gamma_1 = 1.0$	Remarks
Exposure range in negative	50:1	30:1	20:1	20:1	
Negative γ_1	0.875	1.0	1.0	1.0	Constant
Positive γ_2	1.25	1.25	1.1-1.2	0.7	Constant
Over-all γ_{12}	1.1	1.25*	1.1-1.2†	0.7‡	Constant
Density range in positive	1.6	1.85	1.4	0.9	

* Requires electrical expansion in the high-light range.

† See Fig. 23.

‡ See Fig. 24.

Reference 1 and Part III of this paper.) A kinescope beam defocused or vertically enlarged to produce a "flat" field has an equivalent rectangular cross section equal to the pitch distance of the raster lines. With a flat field a given brightness range in the kinescope image can be recorded on film with normal exposures. Normal sensitometric conditions are maintained also for the case in which a smaller scanning aperture produces a line structure on the kinescope which is not resolved by the combination of lens and negative film, resulting again in a flat field on the negative.*

An equivalent line cross section, smaller than the raster pitch distance, requires an increase of the kinescope line brightness by the ratio of pitch distance to line width in order to maintain a given image brightness. Hence, when a high-resolution kinescope is focused sharply and the dark spaces between raster lines are, for example, equal to the line width, the line intensity doubles. To record the increased line-brightness values within the normal range on the film transfer characteristic, the exposure of negative film with adequate resolution (for example on a 4×5 in. film) must be reduced to one-half the value found normal for a flat field (defocused case). The negative is given a normal development but will appear underexposed, because part of the film area remained unexposed by the black raster spaces. For a perfectly sharp recording, the minimum transmittance ($\bar{\tau}_{\min}$) of the negative cannot be expected to decrease below the theoretical value:

$$\bar{\tau}_{\min} = (\text{pitch distance}) - (\text{equivalent line width})$$

Measurement of true line-density values,

* It is noted that a "flat" field requires a constant spot diameter and perfect uniformity of line spacing, conditions which are difficult to realize with rasters containing 500 or more lines. The effects on resolution will be discussed in Part III.

D or D_{\max} , requires use of a microdensitometer to read an area within the line cross section.

Printing of a sharp line raster negative with normal line densities on a positive film requires a normal exposure, but the "weighted" transmittance of the positive cannot exceed the maximum value:

$$\bar{\tau}_{\max} = (\text{pitch distance}) - (\text{equivalent line width})$$

irrespective of the resolution of this process. Projection of the positive requires a higher film illumination, but contrast range and over-all transfer characteristic are normal. A print on paper, however, results in a reduced contrast range because of the unchanged "black" limit of the paper. High lights are "gray" due to light transmission and exposure through the clear spaces separating the exposed raster lines in the negative. In practice, neither kinescopes, lenses nor negative film can maintain perfect contrast between raster lines and "black" spaces throughout the tone range. Practical "resolving apertures" (see Section A) have a nonuniform light distribution which causes a gradual change of light intensity and exposure between line centers. Test exposures on 4×5 Super XX Film made with a defocused kinescope spot and, subsequently, with a sharply focused spot approximately $\frac{1}{2}$ line-pitch in diameter, have shown that an exposure reduction by a factor of two for the sharp-line negative resulted in a slightly higher density of the scanning lines and a "weighted" density range of 0.19 to 1.0; the density range of the defocused negative was 0.3 to 1.2. The two negatives received identical processing. Contact positives were made by printing both negatives side by side on one sheet of film. The weighted densities, \bar{D} , of the fine-line positive were higher by $\Delta D \simeq 0.3$ (due to the black spaces between lines). With correspondingly adjusted illumination, the tone scales of the two positives

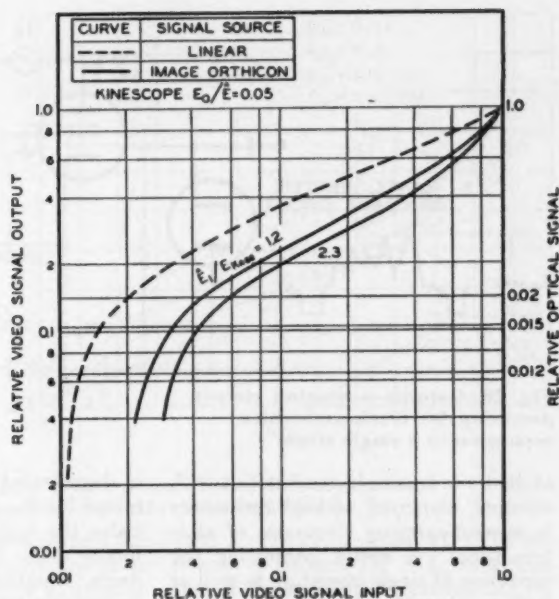


Fig. 25. Transfer characteristics of gamma-correction amplifier providing over-all gamma of unity.

were substantially the same at a normal viewing distance, the fine-line positive being preferable for its sharpness. The effective transfer characteristic of an imaging process transducing a raster image with a nonuniform intensity distribution over the line cross section is actually a *weighted transfer characteristic extending over a greater range of signal values*. The practical equivalent for particular cases is best determined by measurement.

Experience with photography of sharp kinescope images substantiates the requirement of a transfer characteristic with a somewhat longer range or, as pointed out above, a reduction of the kinescope brightness range (raised black level).

9. Gamma Correction in Television Systems

The point gamma values in the over-all transfer characteristic are the product of the respective point gammas of all component characteristics. A low

gamma value in one element can, therefore, be corrected by a high (reciprocal) gamma value in another element. A distorted over-all response characteristic can be made linear by a response characteristic having reciprocal point gamma values. Gamma correction characteristics for several normal television system characteristics are shown in Fig. 25. The characteristics are constructed by selecting equal light values for input and output of the system and plotting the corresponding camera-tube output signal (input to the amplifier) versus the input signal (output of the amplifier) of the kinescope. (A scale indicates corresponding optical signal values.)

The transfer characteristics of a video amplifier can, in principle, be modified by the use of nonlinear circuit elements to have any desired shape. Curved transfer characteristics can be obtained by utilizing the normal curvature of one or several electron tubes in parallel or in series. Greater curvatures can be produced by nonlinear resistances such

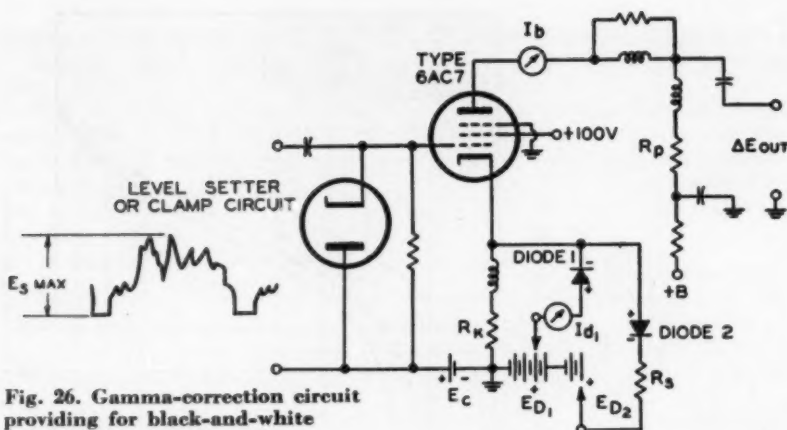


Fig. 26. Gamma-correction circuit providing for black-and-white expansion in a single stage.

as diodes or triodes in combination with resistors, employed as load resistances in current-carrying electrodes of electron tubes. A circuit permitting the correction of single curvature as well as S-shape characteristics in one amplifier stage is shown in Fig. 26. This circuit has a relatively low insertion loss because the nonlinear elements are located in the cathode circuit of the amplifier permitting the use of compensated high-impedance plate loads which must remain constant. The voltage gain of such a correction stage for a linear signal source is in the order of 0.75 for a 20-mc channel* and proportionally higher for lower passbands. The larger signal voltages required for correcting strong curvatures are handled easily by a small amplifier tube (6AC7).

At zero signal input, diode 1 (black expander) of Fig. 26 is made to conduct a current the value of which is determined by the voltage, E_{D1} . The diode impedance shunts the cathode resistor, R_k , with a relatively low value; the amplifier gain is high. When the amplitude of the signal current equals the initial diode current, diode 1 becomes an open circuit and the amplifier gain

is degenerated to a lower level determined by R_k . At higher signal amplitudes the cathode potential rises and finally diode 2 (white expander) conducts, shunting R_k by its impedance (adjustable by R_3), and thus increases again the amplifier gain. The graphic construction of the transfer characteristic from the conductance characteristics of the cathode circuit elements is illustrated by Fig. 27 for the case in which the amplifier stage also performs the function of a black-level clipper. The current-voltage characteristic, I_k vs. E_k , of the cathode circuit results from simple addition of the currents of the parallel elements (vertical addition of curves R_k , D_1 and D_2); the series characteristic, I_b vs. E_b , for tube and cathode circuit results from (horizontal) addition of the grid-to-cathode voltage, E_{gk} , of the tube and the cathode-to-ground voltage, E_k , of the circuit. The transfer characteristic, I_b vs. E_s , of plate current versus signal input voltage, E_s , is finally obtained by subtracting the screen-grid current from corresponding cathode-current values.

The graphic determination of the circuit constants required for a given gamma correction (broken-line curve, Fig. 25) is illustrated in Figs. 28a, 28b

* This type of circuit has been in use by the author for many years.

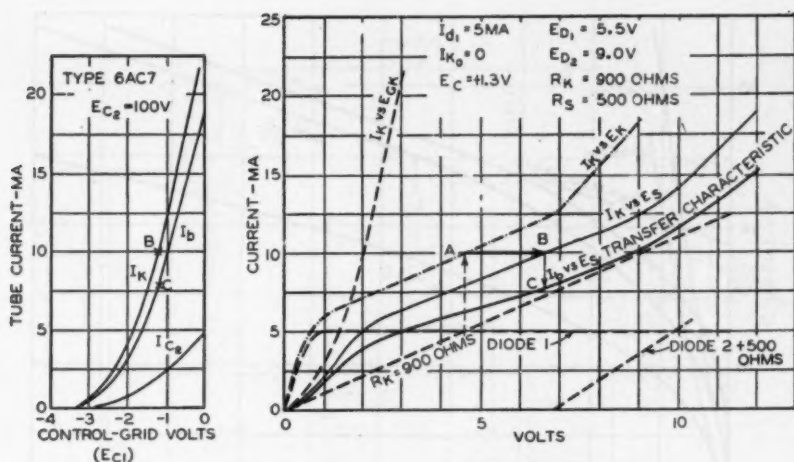


Fig. 27. Graphic construction of transfer characteristic of gamma-correction circuit (Fig. 26).

and 28c. Plate and cathode current for the amplifier tube (6AC7) are drawn in linear coordinates. When a zero-signal plate-current value ($I_{b0} = 6$ ma for the example) is selected, the desired plate current versus signal characteristic, I_b vs. E_b , is drawn with a current range (6 to 16 ma) within the range of the tube. The voltage range is selected to avoid a crossover with the tube characteristic, I_b , as shown in Fig. 28a.* The characteristic, I_b vs. E_b , is now constructed by adding the screen-current values, I_{c2} , corresponding to the plate currents, I_b . Subtraction of the grid-cathode voltage, E_{GK} , (horizontally) from this curve results in the cathode network characteristic, I_b vs. E_b . A line drawn tangent to this curve furnishes the value of the cathode resistance load, R_k (1450 ohms). The load, R_k , intersects the current axis at $E_b = 0$ and a current value, I_{b0} , equal to the total current in R_k at zero signal (13.5 ma). The voltage, E_b , between cathode and ground follows from Ohm's law ($E_b =$

$1450 \times 0.0135 = +19.6$ v). The difference in current, $I_{b0} - I_{b0}$, as a function of E_b is plotted by subtracting the curve, I_b vs. E_b , from the R_k characteristic. It represents the required diode circuit characteristic, I_d vs. E_d (Fig. 28b). This characteristic is now broken up into sections which can be obtained with available diodes. Figure 28b shows the component curves D_1 , D_2 , D_3 , which can be obtained with germanium diodes and series resistances (Fig. 28c). The zero-signal diode currents (1.9, 1.0 and 3.4 ma) are obtained from the curves as well as the diode biasing voltages which exceed E_b (19.6 v) by the voltage drop of the diode characteristics D_1 , D_2 , D_3 . For the example, the diode bias potentials are: $E_{D1} = +20.2$ v, $E_{D2} = +21.1$ v, and $E_{D3} = 23$ v.

The curve, I_d vs. E_d , can be approximated with two diodes, but it is cautioned that too sharp a break in a transfer characteristic may cause a "quantizing" effect, which is a spurious contour at gradation values corresponding to the break point.

The diagram of a practical gamma-correction circuit with adjustable black-and-white expansion is shown in Fig.

* A lower voltage range will be found to require an amplifier tube having a steeper plate-current characteristic than shown.

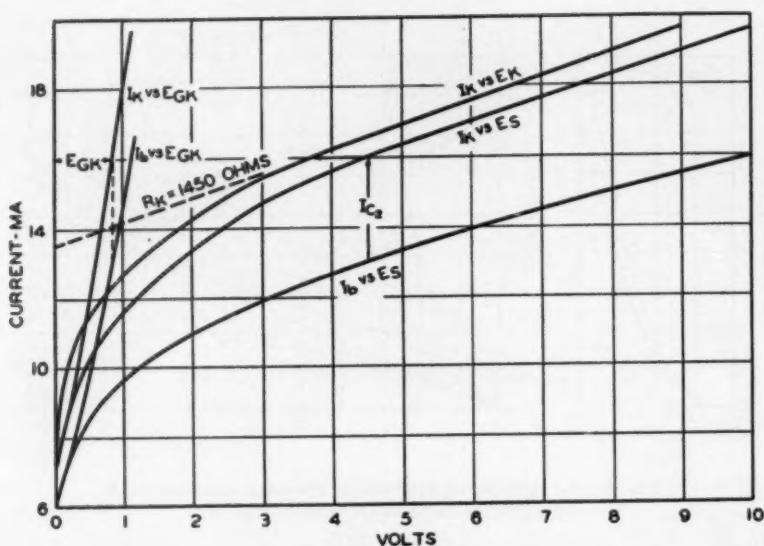


Figure 28a.

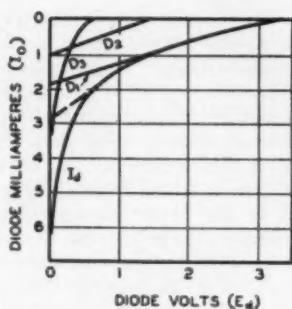


Figure 28b.

Fig. 28. Graphic determination of circuit constants required for a given gamma correction.

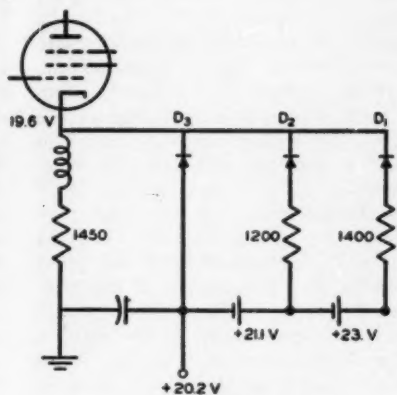


Figure 28c.

29. It is essential to maintain a constant operating point, I_{b_0} , on the tube characteristic by a level setter which establishes a fixed operating bias for the tube. The bias voltages for the black-expansion diodes, D_1 , D_2 , D_3 , are

obtained from a tapped bleeder circuit in which a heavy bleeder current maintains substantially constant potentials with varying diode currents. The black-expansion control changes the diode bias values in proportion, main-

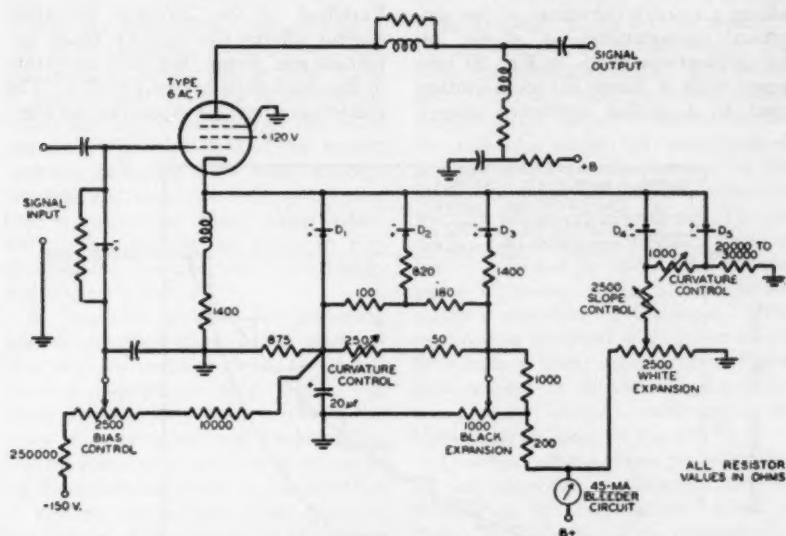


Fig. 29. Gamma-correction circuit with adjustable black-and-white expansion.

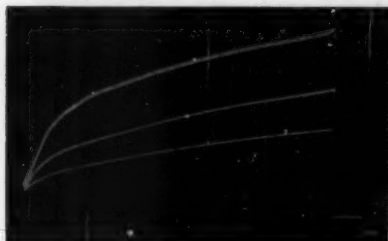


Fig. 30. Oscillograms of transfer characteristics for various settings of black expansion control in Fig. 29.



Fig. 31. Oscillograms of transfer characteristics for various settings of curvature control in Fig. 29.



Fig. 32. Oscillograms of transfer characteristics with black-and-white expansion obtained with Fig. 29.

taining a smooth curvature of the correction characteristic as shown by the oscillograms given in Fig. 30 (obtained with a linear sawtooth-voltage input to a similar correction stage).

Variation of the 250-ohm curvature control affects the relative diode potentials and, hence, the knee curvature of the characteristic (see Fig. 31). The correction circuit for expanding the high-

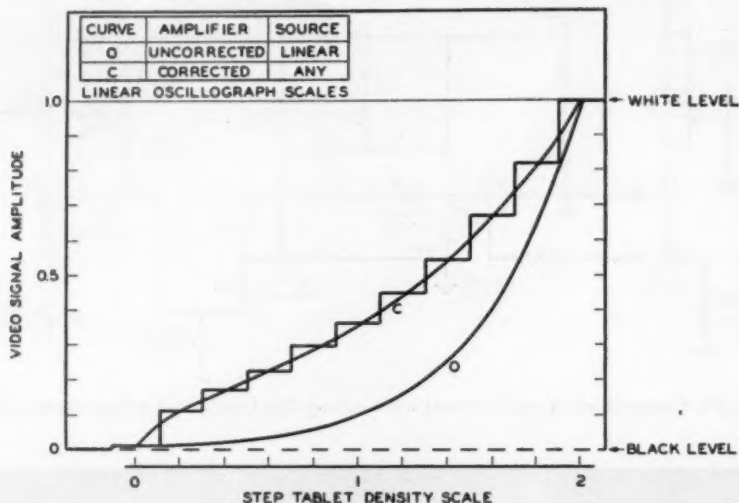


Fig. 33. Transfer curves of camera tube and video amplifier in semilog coordinates, showing an uncorrected characteristic, O, and characteristic, C, with proper correction.

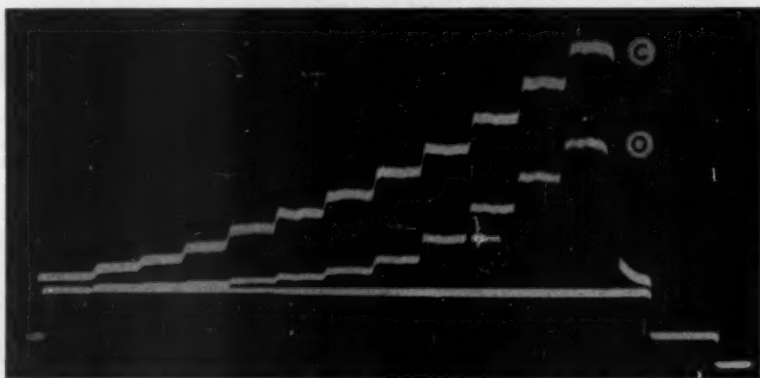


Fig. 34. Oscillograms of transfer characteristics of light-spot scanner (linear) and video amplifier with correction, C, and without correction, O. Step tablet density range $\Delta D = 2$.

light range (reversed diodes D_1 and D_2) is similarly adjustable. The setting of the white expansion control determines the point at which the gamma starts to increase and the slope control determines the desired increase of the point gamma. The high-light diode circuit operates normally with small average currents and does not require a heavy bleeder current to obtain stable potentials. The oscillograms given in Fig. 32 illustrate characteristics with black-and-white expansion.

A practical method for adjusting gamma-correction stages is the observation with an oscilloscope of the signal from a logarithmic step tablet. A linear transfer of signals between the point of observation and the kinescope control grid and a linear over-all transfer characteristic require a characteristic of voltage versus light input which is the inverse of the kinescope character-

istic. When the light input is changed logarithmically along a cross section of the picture, the linear oscilloscope time base represents a log-scale. The oscillogram of the step tablet is, hence, a semi-log plot of the corrected camera transfer characteristic which, for unity over-all gamma, must be the inverse of the kinescope characteristic regardless of the type of camera tube or signal source used. The gamma-correction stage is, hence, adjusted to obtain the transfer curve, C , shown in Fig. 33. (Note the upward curvature of the steps.) The oscillogram obtained with linear amplifiers from a linear signal source (light-spot scanner or orthicon) is shown for comparison. Actual oscillograms for these cases are given in Fig. 34.

The effectiveness of gamma correction in the amplifier is demonstrated by comparing the photographs given in Figs. 35 and 36. The photographs,

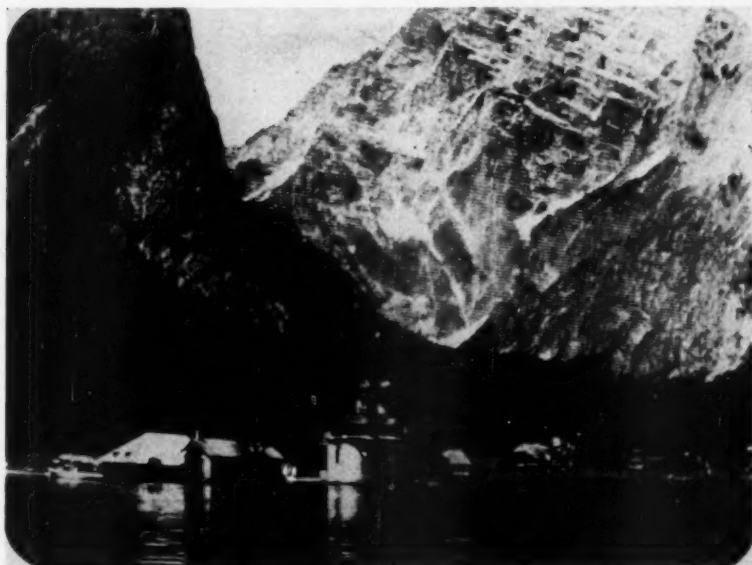


Fig. 20. Television reproduction of 35-mm motion picture frame from special low-gamma SMPTE test film. Bandwidth = 10 megacycles; scanning lines = 525; interlaced 2:1.

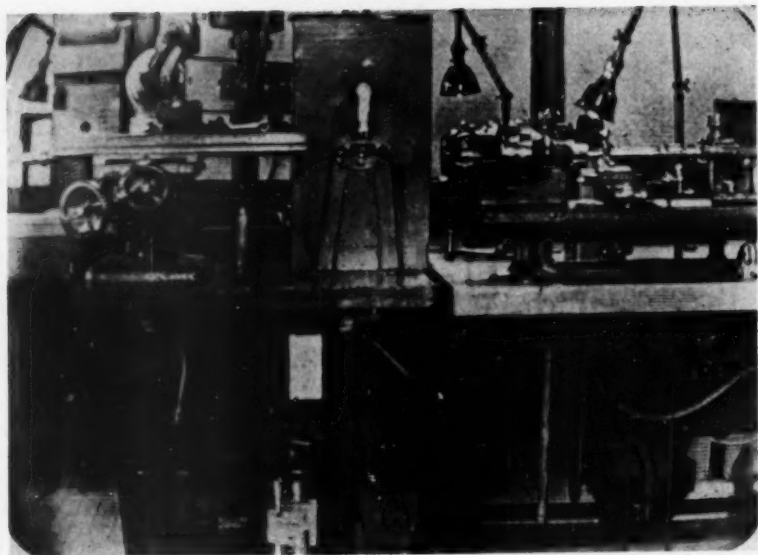


Fig. 8a, b. Poor quality television picture caused by over-exposure of image orthicon. Bandwidth = 4.25 megacycles; scanning lines = 525; interlaced 2:1.

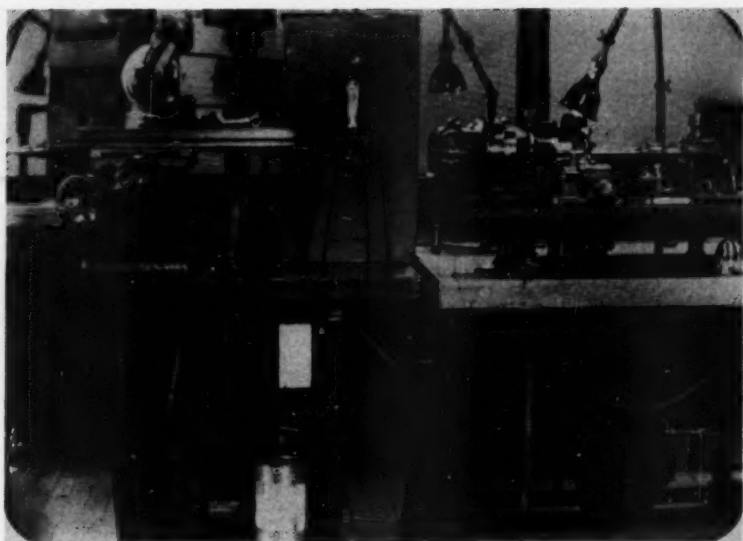


Fig. 9a, b. Good quality television picture obtained with proper exposure of image orthicon. Bandwidth = 4.25 megacycles; scanning lines = 525; interlaced 2:1.



Fig. 35a, b. Photograph of optically projected 2×2 in. slide.



Fig. 36a, b. Photograph of television reproduction of 2×2 in. slide; light-spot scanner with gamma correction. Bandwidth = 4.25 megacycles; scanning lines = 525; interlaced 2:1.

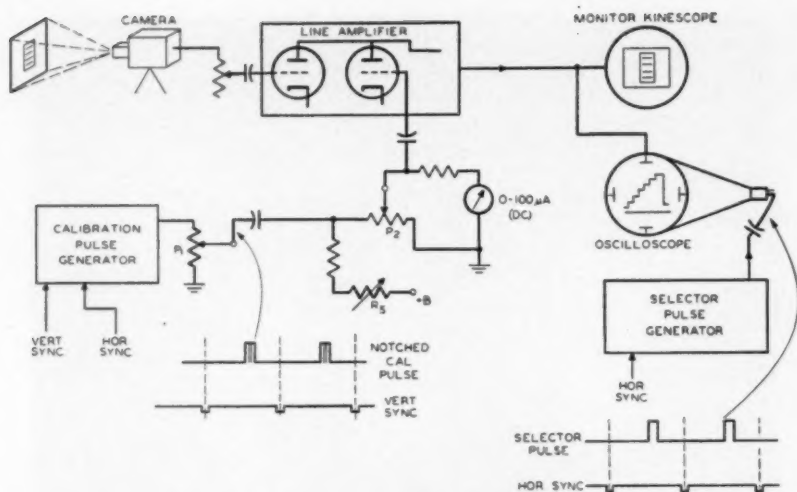


Fig. 37. Block diagram of vertical-cross-section selector and signal-measuring system.

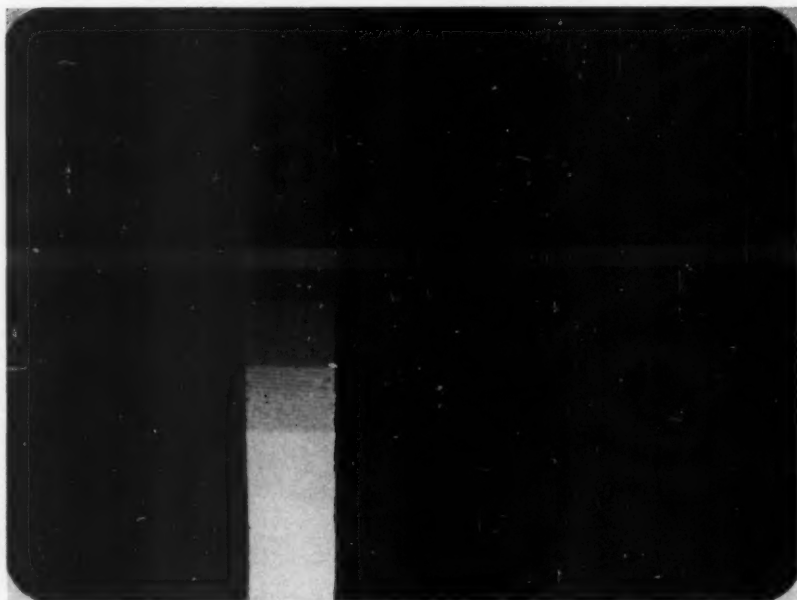


Fig. 38. Step tablet and calibration pulse on kinescope screen.

Figs. 35a and 35b, were made of a direct optical projection (coated lens, Kodaslide Projector Model 24) of two excellent miniature slides (obtained from the Eastman Kodak Co.) on a matte paper screen. The television reproductions, Figs. 36a and 36b, made with a corrected light-spot scanner of the same slides, are photographs of a 16-in., 525-line kinescope image reproduced over a standard 4.25-mc television channel. A negative film size of 4×5 in. and a 1.5-sec time exposure at $f/16$ minimize deterior-

ation of image sharpness by the photographic process which was identical in both cases.

It is cautioned that the correction of transfer characteristics is accompanied by a change of the "noise"-to-signal ratio proportional to the gamma (γ) of the correction characteristic. The subjects of random fluctuations in the television and photographic processes as well as resolution and detail contrast will be discussed in Parts II and III of this paper.

APPENDIX

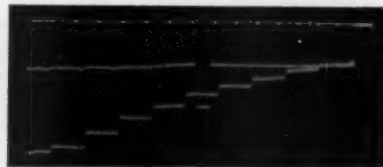
1. Measurement of Camera-Tube Transfer Characteristics

An illuminated step tablet covering a range of 100 to 1 in ten equal logarithmic steps ($\Delta D = 0.2$) is placed vertically in the viewing field of the camera. The magnification is adjusted for a step size of 5 to 10% of the picture width on the kinescope. A vertical cross section of the step signal is obtained on an oscilloscope operated with a 60-cycle linear time base by applying to the oscilloscope control grid a positive horizontal pulse voltage of 5 to 10% of the line duration, timed by a double line frequency pulse to occur in the center of the field. The strip image from the camera is displaced horizontally against the vertical cross section selected by the pulse so that part of a uniform background adjacent to the step tablet produces a reference level signal on the oscilloscope (see Fig. 34). Depending on the background

along the step tablet, the reference signal represents a black, white or gray level against which the step signals are measured. To eliminate errors due to amplifier nonlinearity and to permit expansion of small signals, the step signals are measured by a substitution method. A "notched" calibration pulse, several scanning lines wide, repeating at 60 cycles/sec is superimposed on the low-level signal from the camera (Fig. 37). It appears on the kinescope as a horizontal strip (see Fig. 38) which can be made to pass over any step of the tablet by vertical displacement of the tablet or its image (panning). The calibration pulse displaces a section of the oscillograph trace vertically (Fig. 39) permitting it to "lift" or depress (when of opposite polarity) a section of the reference level into the step level. The signal difference is thus equal to the pulse voltage. A convenient method



a. Partial displacement.



b. Pulse amplitude equal to step signal.

Fig. 39. Oscillogram of step tablet and superimposed calibration pulse.

for reading the relative calibration pulse voltage is indicated in Fig. 37. Potentiometer P_2 (200 ohms) is a voltage divider for the pulse voltage and an auxiliary d-c voltage which is adjusted by the series resistance, R_s , to give full-scale deflection on a d-c meter (0-100 μ a) when P_2 is set for maximum output. With the selector pulse superimposed on the highest step level from the reference signal line, the maximum pulse signal lifting the reference level into the step level is set by potentiometer P_1 . All other levels are then matched by adjusting P_2 and the d-c meter reads directly the relative step intensities.

Signal increments for adjacent steps can be measured by the same method. It must be considered, however, that redistribution, flare or edge effects in camera tubes can tilt the step signals.* The measurement of signals with respect to an adjacent level representing a constant light value at the source is, therefore, less likely to introduce errors because it is independent of shading. The characteristics of the image orthicon (Fig. 6) were measured by this method. Target bias values of less than 2 v result in widely different characteristics for dark and light backgrounds (see references 1 and 3) when it is attempted to cover a large light range.

2. Operation Requirements for Systems With Gamma-Correction Amplifiers

(a) Black-level variations are amplified. The controlling operator must be able to observe the corrected video signal.

(b) The signal gain between camera and correcting circuit should remain fixed once it is adjusted to give the correct relation between transfer characteristics. Adjustment of signal amplitudes from camera tubes with non-linear characteristics should be made by controlling the exposure (mechanical

or electronic shutter, iris, or neutral filters).

(c) Special effects requiring resetting of exposure, gain, or correction as well as equalization of a bank of cameras, may require a separate quality-control position. In this case, the camera video man exercises control over electrical focus, beam current and shading. He should see the corrected picture and may control target bias according to instructions from the quality-control operator.

(d) Expanded sections of the tone scale have a higher "noise" level, and compressed sections have a lower noise level. (See Part II.) A normal corrected tone scale results, in most cases, in a lower average brightness of the image than that obtained by overexposure of the image orthicon, although the highlight brightness is held constant. There may be a tendency to increase the picture brightness by increasing the signal amplitude to the kinescope, which results in higher visibility of fluctuations (noise).

The British and other European television systems operating with a 50-cycle frame frequency are limited by flicker to an image brightness which is lower by a factor of six to ten in comparison with American standards. A low picture brightness lowers the threshold of the eye for observing fine detail and fluctuations giving, therefore, the impression of a higher quality level.

3. Calculation of the Average Number of Quanta in One Lumen of White Light

The ratio of the luminous flux, F , to the radiated flux, P , within given wavelength limits, $\Delta\lambda$, is usually expressed in lumens per watt (lm/w):

$$(F/P)(\Delta\lambda) = 680 (\bar{Y}_l \bar{Y}_r)_{(\Delta\lambda)} \text{ lm/w}$$

where Y_l = relative luminosity factor
 Y_r = relative energy factor of source

$(\bar{Y}_l \bar{Y}_r)_{(\Delta\lambda)}$ = average value of products in the range $\Delta\lambda$.

* See Reference 1, Part IV, Fig. 81.

The factors, Y_i and Y_r , are unity at the reference wavelength, $\lambda = 0.555 \mu$. The radiant energy giving one lm of light within the limits, $\Delta\lambda$, is hence:

$$P_{(\Delta\lambda)} = 0.00147 / (\overline{Y_i Y_r})_{\Delta\lambda} = 1.47 \times 10^4 / (\overline{Y_i Y_r})_{(\Delta\lambda)} \text{ ergs/sec}$$

The energy per quantum is the product of Planck's constant:

$$h\nu = 6.547 \times 10^{-27} \text{ ergs/sec}$$

and the frequency of the light $\nu = 3 \times 10^{14} / \lambda$ (λ in microns):

$$h\nu = 19.641 \times 10^{-12} / \lambda \text{ ergs/sec}$$

Expressed with respect to the reference wavelength $\lambda = 0.555$:

$$h\nu = 3.54 \times 10^{-12} (0.555 / \lambda)$$

where $(0.555 / \lambda)$ is the relative energy factor.

The number of quanta in the radiated energy yielding one lumen of light is hence:

$$\begin{aligned} n_{r(\Delta\lambda)} &= (P/h\nu)_{(\Delta\lambda)} = (1.47 \times 10^4 / 3.54 \times 10^{-12}) / \left(\overline{Y_i Y_r} \frac{0.555}{\lambda} \right)_{(\Delta\lambda)} \\ n_{r(\Delta\lambda)} &= 4.16 \times 10^{15} / \left(\overline{Y_i Y_r} \frac{0.555}{\lambda} \right)_{(\Delta\lambda)} \text{ quanta/lm} \end{aligned}$$

where the bracketed term is the average product of the relative energy factors over the range, $\Delta\lambda$. For noon sunlight or a black body at 5400 K and the limits $\lambda = 0.40$ to 0.73μ , the above equation gives the quantum number:

$$n_{r(\Delta\lambda)} \approx 1.3 \times 10^{14} \text{ quanta/lm}$$

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Technical Activities of the Motion Picture Research Council

By W. F. Kelley and W. V. Wolfe

A brief description is provided for the more important technical activities, including work in progress on composite photography, lighting equipment, wind machines, strippable adhesives, transportation equipment, plastics, diffusion cloths and other items of interest in the production of motion pictures. Mention is also made of the Research Council's function in connection with new products, inventions, television, stereoscopic motion pictures, standards and test films.

ALTHOUGH the history and functions of the Motion Picture Research Council were covered in an earlier paper before this Society,¹ it seems desirable to review briefly that information.

Originally, there was formed about 1928 the Technical Bureau of the Academy of Motion Picture Arts and Sciences. In 1932 the name, along with some of its functions, was changed, forming the Research Council of the Academy of Motion Picture Arts and Sciences. For fifteen years the Research Council existed largely as a secretariat relying upon voluntary services of studio and equipment manufacturers' personnel for most of the work carried on.

By 1947 it was freely recognized that insofar as methods, processes and equipment are concerned, there was no need for competition among the producers

of motion pictures. Accordingly, it was practical to carry on the development of such equipment, processes and methods in a common industry-sponsored technical organization. With this end in view, the Motion Picture Research Council was separated from the Academy of Motion Picture Arts and Sciences and incorporated under the laws of the State of California. Funds and facilities were made available and the business of organizing a staff of qualified technical people and securing for them the necessary equipment and quarters was undertaken.

The Research Council is interested in any and all technical problems in the production or exhibition of motion pictures. In general, the activities can be divided into three groups: service functions, short-range development and design problems, and long-range advanced development problems. The staff includes two physicists, three chemists, two mechanical engineers, two electrical engineers and supporting personnel.

Figure 1 shows the large half of the mechanical and electrical laboratory

Presented on October 19, 1950, at the Society's Convention at Lake Placid, N. Y., by W. F. Kelley and W. V. Wolfe, Motion Picture Research Council, Inc., 1421 N. Western Ave., Hollywood 27, Calif.

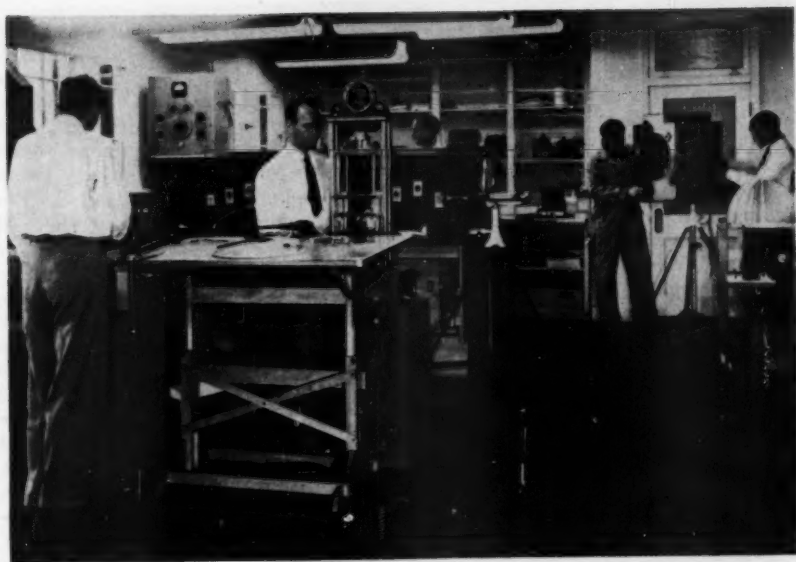


Fig. 1. Mechanical and electrical laboratory.

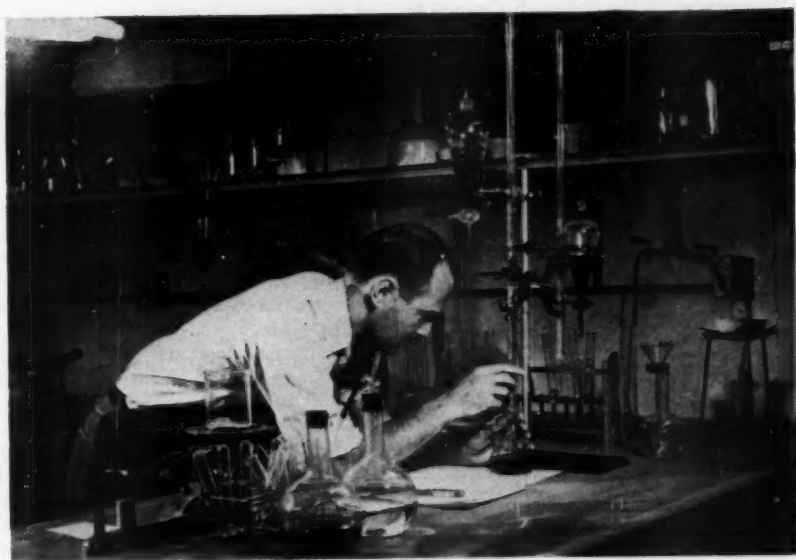


Fig. 2. Chemistry laboratory.

while Fig. 2 is one small corner of the well-equipped chemistry laboratory. Formalized laboratories of this type do not fit too well the type of work carried on by the Research Council since much of this work involves problems which can be properly studied only on a motion picture stage which, fortunately, is available through the cooperation of 20th Century-Fox on whose Hollywood Western Avenue lot is located the Research Council's office.

Although the Research Council now has its own technical staff and facilities, it needs the guidance of the many expert technicians of the industry. This is provided through a group of 14 basic committees covering every phase of the technical activity of the industry.

The Research Council is a small organization covering a broad and diverse field. Its only possible chance of working successfully under such conditions lies in the cooperation which it seeks and receives from other industries throughout the country. Since it is the purpose of the Research Council to serve the motion picture industry, it is not concerned with glory in solving problems, but only with the solution. If any other organization has a satisfactory answer, then the aims of the Research Council have been completely satisfied when that answer is made available to the industry. The cooperation of film manufacturers, equipment manufacturers, chemical companies and many others too numerous to name is gratefully acknowledged and deeply appreciated.

Set Lighting

Projects of many types and varieties are undertaken by the Research Council, either on its own or in cooperation with other companies. For example, set lighting is one of our most important projects. We will be concerned with it as long as there is a motion picture industry. Presently we are carrying on work on set lighting in all three branches

of our activity, that is to say, service function, short-range design and development and long-range advanced development. Some time ago, the industry became seriously interested in the use of sealed-beam lamps and a very careful study of their application was made. This was reported in a paper before this Society at the Fall Convention in 1949.² Figure 3 shows an actual motion picture set at Paramount Studio which was arranged to be lighted by either sealed-beam or standard studio lamps in order that photographic tests might be made under actual operating conditions. Figure 4 shows a mercury-cadmium lamp under test. The "Man from Mars" helmet is, of course, a standard welder's helmet, equipped with special glass to permit safe viewing of the intense light produced by this mercury-cadmium lamp. Since this lamp is contained in a quartz bulb, it produces high intensities in the ultraviolet, so that artificial sunburn is difficult to avoid. In studying lamps of this type, it is necessary to know as much as possible about their color quality and variation, if any, in color quality as a function of age and various operating conditions. Such studies are made with a spectroradiometer and filtered light meters, and also photographically.

Studies of the zirconium arc, both enclosed and open-air varieties, have been carried on, although for set lighting purposes these arcs do not appear to have sufficient intensity or satisfactory color temperature.

The xenon gas arc has long been known and studied and is perhaps most familiar to us in the flashtubes so successfully used for stroboscopic high-speed photography. Not so well known is the fact that in Germany and England development work has been in progress on a high-intensity xenon arc of capacities ranging up to 1000 w. In Germany an air-cooled lamp of this type has recently emerged from the research lab-



Fig. 3. Production test setup: sealed-beam versus standard studio lamps.



Fig. 4. Mercury-cadmium lamp under test.

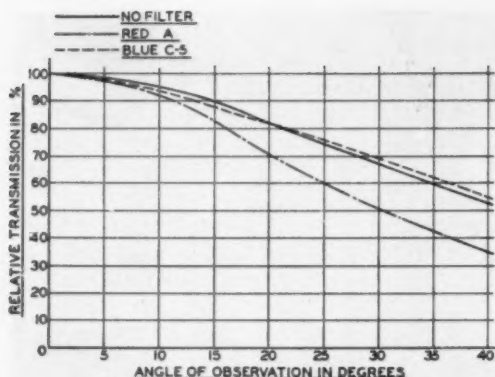


Fig. 5. Typical brightness fall-off curves—goniophotometer measurements.

oratories. It is being watched with care and samples will be obtained by the Research Council as soon as possible. This lamp has better color characteristics, having almost a continuum throughout the entire spectrum and a color temperature of the order of 6000 K (degrees Kelvin), coupled with instant starting. If it can be made commercially available, it can occupy a position of real importance in set lighting for motion pictures.

Composite Photography

Composite photography is a matter of vital importance to the motion picture industry. It permits making many shots which would otherwise be impossible, and making many more shots which would be impractical from an economic standpoint if made by any other process. There are two general types of composite photography, commonly called transparency process photography and matte photography. Both of these forms of composite photography are under study. Some of the work done on process screens was reported to the Society at the Fall Convention in 1949,² but much additional work in this field has been done since that time.

A goniophotometer built for our special application has been used to measure the color characteristics of

transparency screens. The results of one such test are shown in Fig. 5. These tests are verified, wherever that is important, by actual photographic measurements, since it must be constantly borne in mind that the characteristics of the photographic emulsion are an inseparable part of the problem. The difference in fall-off characteristics of this particular screen sample at the different ends of the spectrum is of obvious importance for color photography, but is also important for black-and-white photography since it must effect the resultant definition in many cases.

The method of making a composite photograph which consists of photographing foreground objects while simultaneously rephotographing from a screen the desired background, can, of course,

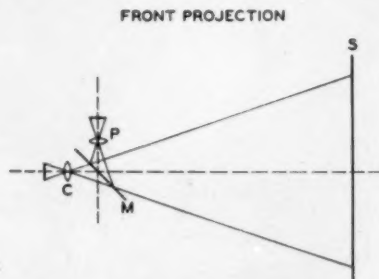


Fig. 6. Schematic drawing of front projection setup.



Fig. 7. Front projection with foreground lighting.



Fig. 8. Front projection without foreground lighting.

be employed with a reflection type of screen and front projection as well as with a translucent screen and rear projection. For example, in Fig. 6 is a simplified setup showing a camera, C, a projector, P, and a diaphone mirror, M. The picture from the projector is reflected by the mirror to the screen, S, and rephotographed by the camera along with the foreground object. Figure 7 is an example of this type of photography, for the young lady is seated in front of what appears to be an open window through which the city may be seen. Figure 8 shows what happens if the foreground lights are turned off so that the camera sees only the silhouette and the rephotographed view of the city. This last slide is included primarily to show that the intensity of light required from the projector is insufficient to register on the foreground object even though it is sufficient to provide a brilliant picture of the background. The differences in reflection characteristics are, of course, responsible for the operation of such an arrangement. There are many problems in connection with the successful use of front projection. The idea is not new, but its application and limitations have never before been properly defined, which is the primary object of the investigation in that field.

The industry has long been intrigued by the considerable increase in efficiency which can be obtained with a directional translucent screen as contrasted to a nondirectional screen, but in most cases the requirement for a mobile camera, coupled with manufacturing problems, has prevented the use of such screens. General awareness of the difficulties and the problems involved in a directional screen and acquaintance with much of the earlier work that has been done on this subject have also stimulated the investigation in that direction. There presently seems some promise of obtaining a directional screen which will permit of camera movement and yet offer a

light gain of four or five times that presently available with the nondirectional screens.

Traveling matte composite photography presents many difficult problems. Presently, it is used in the industry only where there is no other way of making the required picture. This is true because the process is slow, expensive and it is difficult for many people to understand and appreciate the results which can be obtained. The Research Council, in undertaking an investigation of this process, expects, therefore, to work toward a system which will overcome all three of these objections. It is hoped to develop a system which will be fast and inexpensive and will permit the director, cameraman and others concerned to see the composite result at the time the foreground is being photographed. This, of course, can be true only if the background material is already available on a motion picture film. That's a rather ambitious undertaking because it involves problems of optics, photographic materials, lighting and electronics. Preliminary studies, however, lead to the belief that these highly desirable results can be achieved. The expected improvements in this rather old form of composite photography appear possible because of improvements which have been made in photographic film base, emulsions and electronic developments.

The use of projected still backgrounds has long been quite a problem, particularly where color is involved, much of the difficulty arising from the instability of the colors under the high temperature and ultraviolet light conditions which prevail. A further difficulty has been the problem of matching the foreground and background colors, since the foreground is an original and the background is a dupe. These difficulties were demonstrated with a frame of a 35-mm color print [which accompanied this paper but cannot be reproduced in

color in the JOURNAL] in which the lower left-hand quadrant is a direct photograph of a color chart, and the other three quadrants are occupied by projected reproductions of the same color chart. Two of these are still projections and the third is a motion picture projection. While none of these match the original, it is noted that the difficulty is principally in the red end of the spectrum. This is indeed fortunate since still background scenes rarely contain any significant red. Colors in such scenes are predominantly blue and green, where the comparison is not so odious. Nevertheless, this is not a satisfactory situation and it is hoped that new color films which will shortly be on the market will correct or at least improve this situation.

Transportation

Transportation between studios and location is a matter of considerable importance. When the Research Council started to analyze this problem, at the specific request of the production man-

agers, it became apparent immediately that the problem was incapable of solution unless a reasonable amount of standardization of equipment required for a location could be achieved. Most of the equipment required for the average location is classed as "grip equipment" and an analysis covering locations made by each of the member studios of the Research Council for the last ten years developed a definite pattern which, after careful study and consultation with the grip and camera departments as well as a group of outstanding directors of cinematography, was consolidated into a standard group of equipment. This was classed as the basic list to be specified for location unless specific approval for changes was obtained from the production office.

A semitrailer was then designed about this basic list of equipment with provisions for carrying all of the grip equipment, sound equipment, camera equipment and in many cases additional equipment as required for the electrical

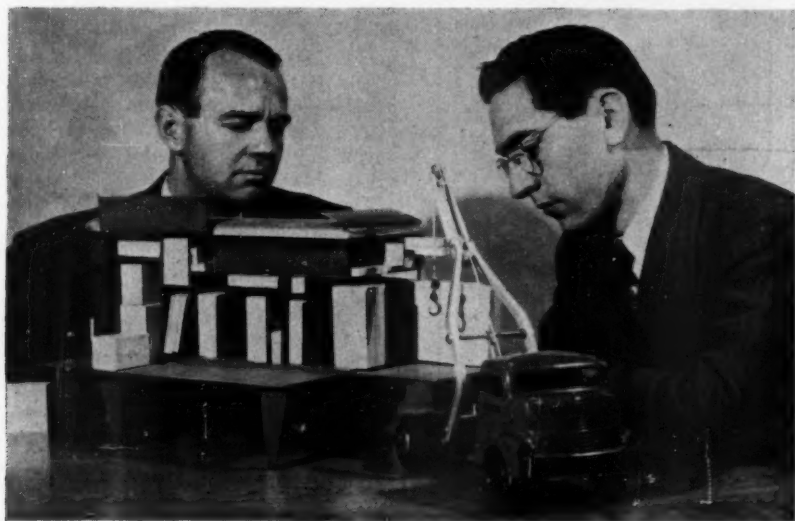


Fig. 9. First model of Research Council transportation unit.

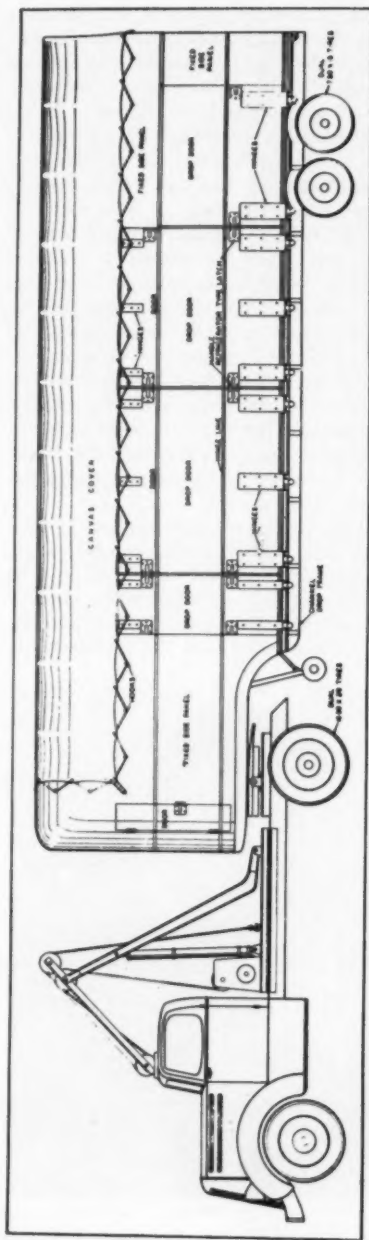


Fig. 10. Final design of "standard" location transportation unit.

department, property department or others. Figure 9 shows a model which was made up to permit graphic discussion of this problem with all of the departments involved. Subsequently, the design was changed as shown in Fig. 10. The folding crane, which is attached to the trailer, can be extended and used to load or unload any of the equipment carried by the semitrailer. It obviously can also be used in many other operations on location.

One of the important problems in designing this unit arose from the variety of state laws controlling the size of vehicles traveling over the roads. Dimensions were finally chosen to meet the requirements in most of the states of the Union. California's neighbor to the north, Oregon, offered the most difficult restriction in a height limitation of 11 ft. The standard design calls for a semitrailer having a height of 12 ft 6 in., but the front top of the semitrailer can be reduced in height to 11 ft, and if the bows are omitted from the balance of the top of the semitrailer, the complete unit can stay under the 11-ft limitation of the State of Oregon, this, of course, being accomplished at some sacrifice of carrying capacity. In most cases it is hoped that a waiver of this restriction can be obtained.

The study and tests which the Research Council has made on the very important problem of film perforations was covered in a separate paper presented at the same Convention.⁴

Wind Machines

There are many applications in the production of motion pictures for an artificial and controlled wind. These requirements vary from hurricane conditions to a gentle zephyr which blows milady's scarf. The hurricane in the past has been created by airplane motors with airplane propellers. In many cases, these motors have been

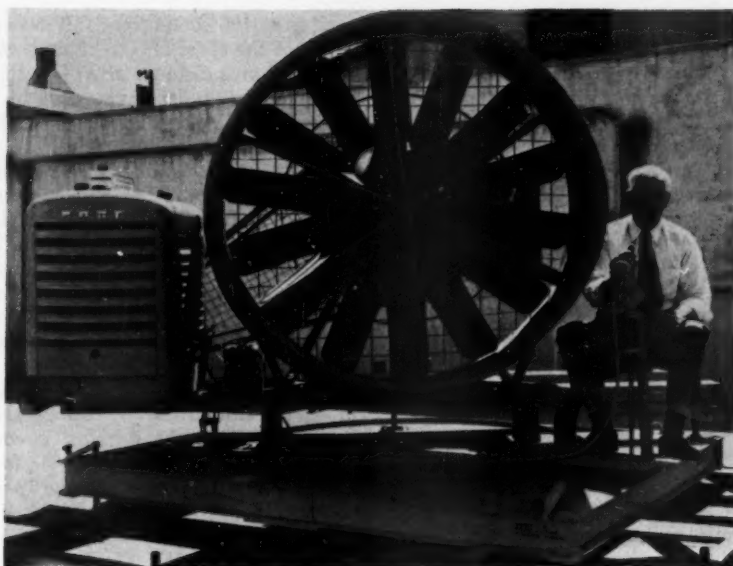


Fig. 11. 6-ft wind machine.



Fig. 12. Effect of windstream 20 ft from the 6-ft wind machine.

Liberty motors of the World War I vintage. Since an airplane propeller is not designed to create wind, this device, while moderately effective, was not controllable to a sufficient degree and was both noisy and expensive to operate.

Figure 11 shows a machine developed by the Research Council for the hurricane type of application. The fan blade is 6 ft in diameter and is a standard unit. The motor is a standard industrial gas engine, developing approximately 150 hp. Provision is made for mounting two of these motors, one on each side of the fan, since about 300 hp is required to drive the fan to full output. This fan may be tilted through a range of from 15° below horizontal to 20° above horizontal. The operator has control of the speed of the fan and can rotate the entire unit through 360°.

Some difficulty has been experienced in measuring the velocity of the wind created by this machine, but Fig. 12 shows graphically the intensity that is possible when the fan is driven at 200 hp. The man in the left foreground is directly in front of the wind machine at a distance of approximately 20 ft and is unable to move closer to the fan. The sharpness of the beam of wind is shown by the fact that the two men in the right foreground are almost completely out of the air stream.

Figure 13 shows the wind machine being used to blanket a set with smoke. The smoke candles can be seen at the rear of the fan.

For use inside the stage during dialog sequences, a somewhat similar wind machine, having blades 3 ft in diameter, was designed and this unit is shown in Fig. 14. Like the larger wind machine, this unit can be panned or tilted as desired. It is also designed to permit separating the fork supporting the fan unit itself from the base so that it can be mounted in a suitable socket on a parallel or on scaffolding. It is driven by a d-c motor at speeds usually in the

range from 100 to 400 rpm. Wind velocities of the order of 8 to 12 mph can be created at a distance of 20 ft with a noise of about 30 db as measured by a General Radio noise level meter on the 40-db scale.

A still smaller unit has been designed, also shown in Fig. 14, again following the basic impeller principle. This unit has a blade which is 18 in. in diameter, but is somewhat similar in many other respects to the 36-in. fan. It is interesting to note that, neglecting the noise made by the driving motor, the smaller the fan the more noise it makes for a given velocity. Thus, if all three fans are driven by comparable electrical motors, the 6-ft fan is considerably quieter than the 36-in. fan, and it, in turn, is quieter than the 18-in. fan.

Motion Picture Sets

Most motion picture sets are assembled from hard flats which consist of plywood panels on light wood frames. These flats are used over and over again. Such sets are almost always covered with paper; if a wallpaper decoration is desired, the wallpaper is pasted directly to the flats; if a painted surface is desired, a blank paper is first pasted on the wall and is then covered with paint. Thus, in either case it is necessary to remove this paper to prepare the flats for reuse. In the past this has been done by various laborious methods, one of which is shown in Fig. 15. Such procedures were not only expensive in terms of time required to remove the paper, but invariably damaged the surface of the flat, requiring refinishing and necessarily reducing the life of the flat.

The Research Council approached this problem in two ways. The first was the use of the so-called "Peel-Coat" which is a paint-like material most commonly known for its use in the storage of military equipment, airplanes, ships, etc., where a cocoon of this material is



Fig. 13. Making smoke with the 6-ft wind machine.

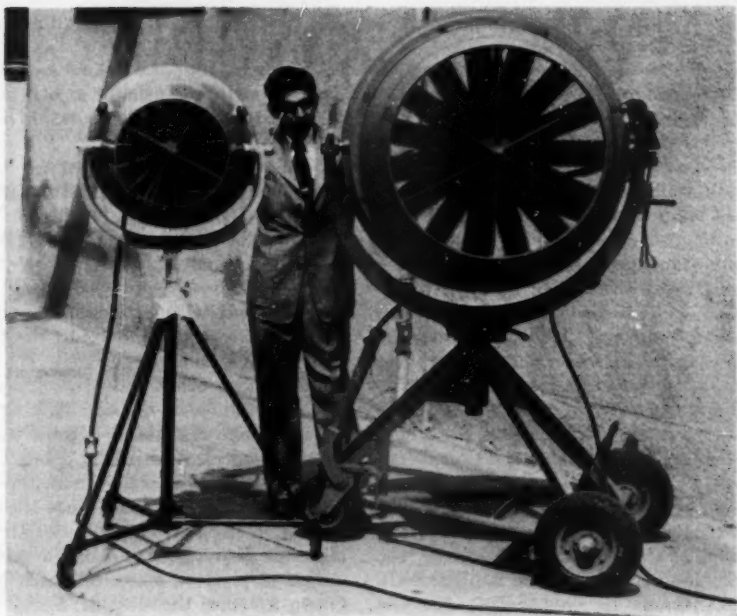


Fig. 14. 18- and 36-in. wind machines.



Fig. 15. Old style method of removing wallpaper from flats.

used to cover the device to be protected. This procedure worked with entire satisfaction, since pigments could be mixed into the Peel-Coat or a coat of paint could be applied over the Peel-Coat, or paper could be applied over the Peel-Coat, and in each case the surface could be stripped easily by the simple operation of making an incision through the Peel-Coat with a knife or other sharp instrument and then stripping the whole business off the flat. However, the process was expensive and did not meet with favor, and as a result, efforts were concentrated on a simpler solution. This came out in a material known as Peel Paste which was developed entirely by the engineers of the Research Council. It has the consistency of ordinary wallpaper paste and permits the paper to be worked in exactly the same manner as the more familiar wallpaper paste. It holds the paper on the wall satisfactorily until it is time to remove it, when again an incision is made

with a knife and the entire section of paper is stripped, usually in one piece. Figure 16 shows such an operation being performed on a standing set.

Similar strippable adhesives have been developed for use with various types of floor covering; rubber tile, asphalt tile, linoleum, parquet floors and similar material. Here, the strippable adhesive permits removing the floor covering without damage to either the floor covering itself or to the floor on which it is laid.

Like most other industries, motion picture studios have been making increased usage of plastics. If one wishes to be technical, it might be pointed out that the motion picture industry depends entirely on plastics since the film base is in itself a plastic material, but there are also a host of other important usages of plastics, many of which have grown up since the close of World War II. The Research Council is constantly testing, in cooperation with the studios,



Fig. 16. New procedure for stripping wallpaper from flats.

new applications of plastics. These include such things as flexible molds for casting plaster, hardening materials to be mixed with the plaster, thermoplastic materials for set construction items such as stair handrails, plastic props, simulating metal with plastic as in the armor worn by knights, a full-scale locomotive and many others.

It is presently standard practice to move set walls from the mill to the stage and from the stage to the scene docks on wheeled platforms called set dollies. These little platforms are made up of a couple of 2×12 's, 3 or 4 ft long, with four 2- or 3-in. free casters. They are inexpensive and their very simplicity makes them extremely versatile, but they also have some distinct shortcomings. Their stability is not good and the

small casters frequently catch in holes in the ground. As a result, the Research Council has undertaken the design of an improved dolly.

All of the major studios own rather extensive, permanent outdoor sets, mostly in the form of streets of one kind or another. If any extensive shooting is to be done on these sets, it is usually necessary to cover them in with canvas so that the direction, intensity and color quality of the light will always be under the control of the cameraman. This means that each of the studios has literally acres of canvas which they call diffusing cloths. These diffusing cloths must be flameproofed to minimize the fire hazard, and this flameproofing treatment increases their weight and makes them more difficult to handle. With or without the flameproofing treatment, the life of canvas exposed to the atmosphere of Los Angeles is relatively short, perhaps two or three years.

The Research Council is, therefore, in the business of studying fabrics. First it seemed that nylon would be a natural answer since it was already flameproof and known to be considerably stronger than cotton fabrics such as canvas. Tests very quickly proved that this was not the answer, as nylon will not stand up under these atmospheric conditions as well as canvas does. Glass cloth is, of course, fireproof and stands up well under atmospheric conditions, but is easily damaged by abrasion and in many cases its tear resistance is low. There is no answer to this problem at the moment, but tests are in progress on nylon and glass cloth, each with a vinyl plastic coating.

Camera Cranes and Dollies

Some time ago the Research Council developed a camera crane which was reported to this Society in a paper presented at the 1948 Fall Convention.⁵ Since that time there has been designed a dolly for this camera crane, as shown in Fig. 17. Pneumatic tires are em-

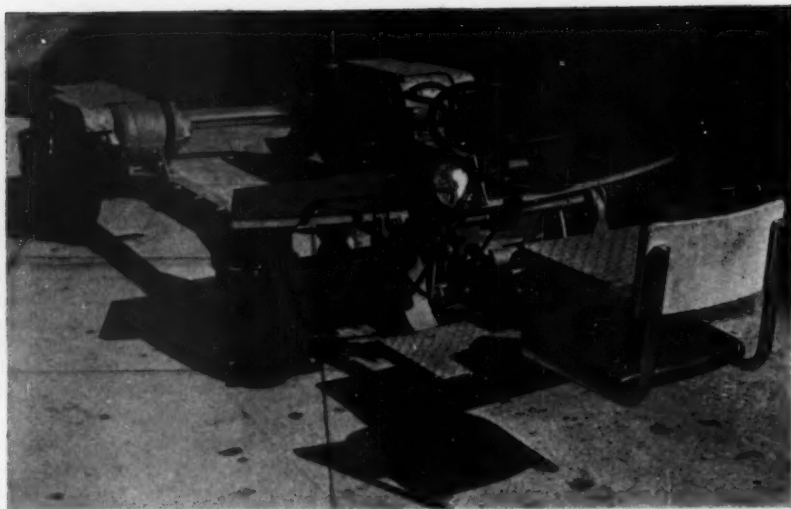


Fig. 17. Camera crane dolly.

ployed and to avoid the necessity for a differential, two series d-c motors are used to drive separately two of the wheels of the dolly. Steering, acceleration and brake have been patterned after those in an automobile in order that the operator may feel at home.

Figure 18 shows a camera crane mounted on the camera-crane dolly. The operation of mounting or removing the camera crane from this dolly can be accomplished without any special tools and without a hoist. It is but a matter of a few minutes' work.

Figure 19 illustrates a camera geared head whose design is quite different from those commonly used in the industry. It permits tilting the camera through an arc of 45° each side of the horizontal and thus has some distinct advantages over other geared heads.

Photography

Figure 20 shows a doorway at night with a light shining through the glass door panels. Actually, the door panels are made of a highly directional reflect-

ing material and the light used was a small spotlight located on the camera. This is an example of a simple application of readily available materials which can be used to good advantage in this industry.

Although a picture is photographed on a two-dimensional medium (the film itself) and projected on another two-dimensional medium (the theater screen), the industry has always wanted a picture in three dimensions. There have been a number of papers before this Society with demonstrations of systems which permit of all three dimensions. Some of these have employed polarized light and others have obtained their separation by color, and similar procedures, but in every case they require the use of some kind of crutch by each individual in the audience, or they restrict the viewer's position and motion of his head in a most unnatural way. So far the industry has been unwilling to make any commercial use of any of these systems, except on a novelty basis.

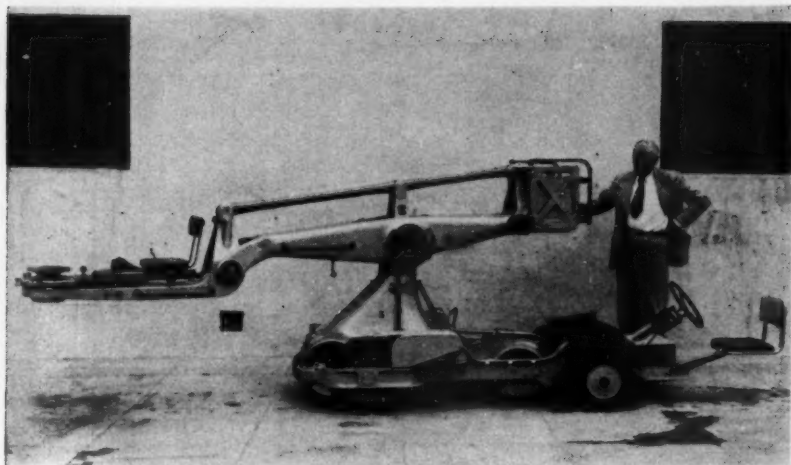


Fig. 18. Camera crane mounted on the dolly.

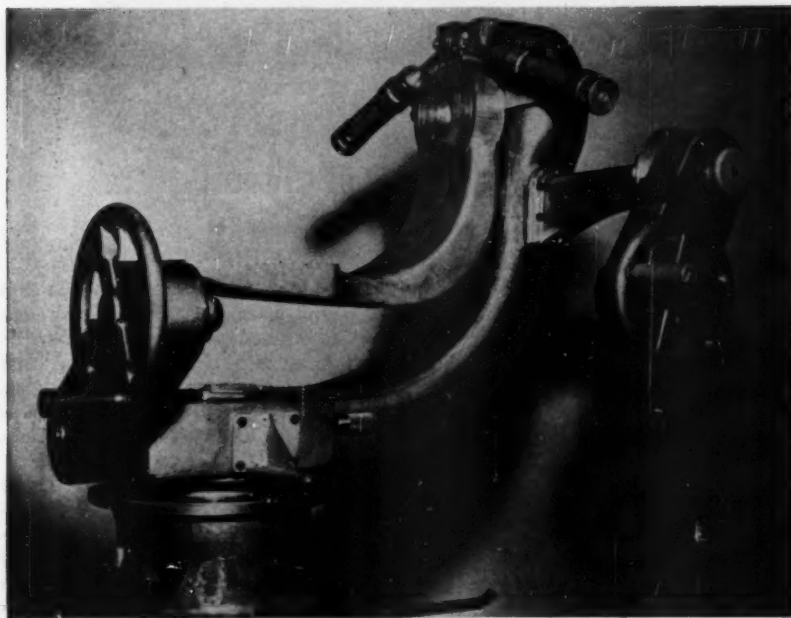


Fig. 19. Geared head.

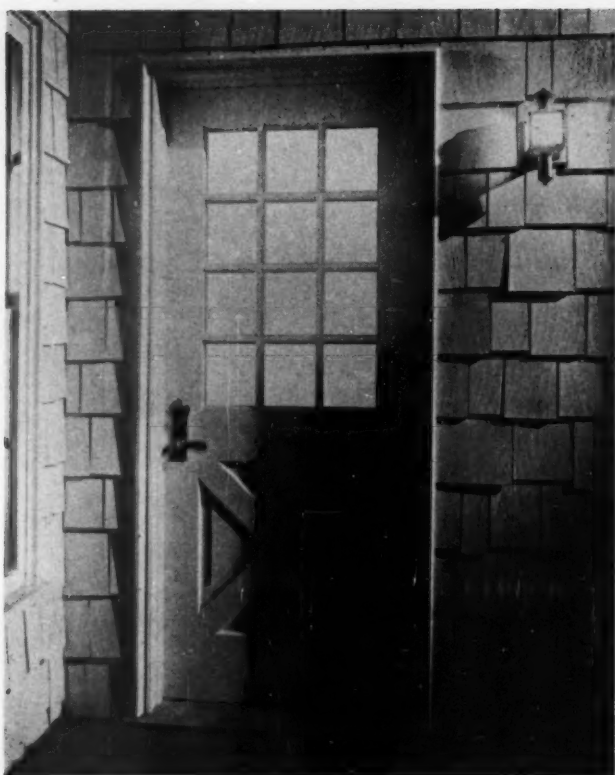


Fig. 20. "Scotchlite" window reflector.

The Research Council is constantly receiving proposals from inventors all over the world for systems to permit three-dimensional motion pictures. So far none of these systems appears practical. Nevertheless, each one is carefully considered and investigated if that seems necessary. In order to understand better the problems of three-dimensional motion pictures, the Research Council has purchased an attachment for a 16-mm camera, as shown in Fig. 21, which permits photographing a stereo pair on the film. Figure 22 shows what this stereo pair looks like on the film. It is turned on its side

to permit maximum usage of the film area and when it is projected through the same attachment used in making the picture, plus a polarizing screen, and viewed with proper analyzing glasses, a motion picture in three dimensions is obtained which is satisfactory for laboratory investigational purposes.

The Research Council activity in connection with color is largely confined to reporting to our member companies on various color systems as they are announced and studying problems of test and control for color systems which seem likely to receive commercial usage. We are consequently interested

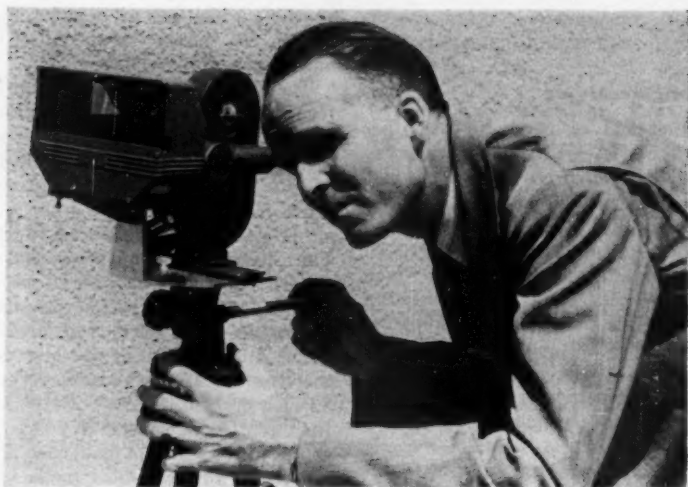


Fig. 21. 16-Mm stereo camera.



Fig. 22. Still shot through stereo attachment.

in color densitometers, color charts, printing machines and similar devices.

Magnetic Recording

In the field of magnetic recording and in the older art of photographic recording, the Research Council has not been particularly active because both the studios and their suppliers are actively at work on these problems. An analysis of the economic problems which needed consideration in connection with magnetic recording was prepared, however, because the differences in operating practices and requirements throughout the industry were creating false impressions which needed correction.

Television

Television presents another situation where the Research Council can only hope to keep abreast of that fast-changing art so that its member companies may be advised when television systems, equipment or techniques reach the place where they can be profitably applied to the production of motion pictures. In other words, the Research Council is not concerned with television as a medium of home entertainment. It is concerned with it as a medium of theater entertainment and as a means of producing motion pictures.

There are many other relatively minor items in which the Research Council is active. They include, for example, problems of flicker, elimination of static on film, special types of storage batteries, new microphone booms and refrigerated film-shipping containers. In fact, the Research Council is interested in

anything which has an application as a tool in the making or exhibition of a motion picture.

There is oftentimes some confusion regarding the relationship of the Motion Picture Research Council to the Society of Motion Picture and Television Engineers. This misunderstanding usually arises from matters having to do with either standards activities or test films. The Research Council works very closely with the Society on all problems of standardization within the motion picture industry, but as a member body of the American Standards Association, the Research Council also acts directly on such problems. The Society and the Research Council work very closely together in the test-film field, each accepting orders for test films made by the other. Test films are looked upon as a service to the exhibition end of the industry which has been undertaken to insure satisfactory presentation of the studio product in the theater.

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Semiautomatic Color Analyzer

By Lloyd E. Varden

A semiautomatic color analyzer is described for rapidly determining the extent of unbalance, or deviation from "type," of a processed color negative or color positive monopak film. A standardized light source, a rotating color filter having three sectors which transmit narrow spectral bands of blue, green and red light, a multiplier-type phototube and amplifier, and a cathode-ray tube are employed. The sweep circuit of the cathode-ray tube is synchronized with the rotating filter wheel so that a horizontal straight-line image is produced when a gray or near-gray density of a "balanced" sample is in the light path. A cathode-ray tube image which deviates from a horizontal straight-line image indicates unbalance in a test sample, whereupon correction filters can be introduced in the light path by means of servomechanism devices to produce a horizontal straight-line or "balanced" condition.

IT IS WELL KNOWN that for many practical purposes a complete energy versus wavelength relationship is not always required to determine the effective spectral characteristics of a light source or of a selective absorbing material in terms of some adopted standard. Tungsten lamps, for example, can be calibrated against a black-body radiator or a suitable secondary standard, and any deviations in spectral emission from lamp to lamp can be expressed as color temperature differences or as voltage differences necessary to produce a constant color temperature. The ratio of only two values of a lamp's spectral emission, one in the blue region and one in the red region, is sufficient for such a specification.

Presented on October 17, 1950, at the Society's Convention at Lake Placid, N.Y., by Lloyd E. Varden, Pavelle Color Inc., 533 W. 57th St., New York 19, N.Y.

Similarly, simplified methods are utilized to express the spectral absorption characteristics of processed multi-layer color films. Integral density measurements made at only three spectral positions—at wavelengths corresponding with the spectral absorption peaks of the dyes formed in the layers—are used for most laboratory control purposes. For color sensitometry, the more meaningful equivalent gray densities are preferred. These can be measured directly or can be derived from the integral densities. Such density measurements, as well as the entire subjects of color densitometry and color sensitometry, are summarized in the recent report of the Color Sensitometry Subcommittee.¹ The only point to be stressed here is that for each density specification three measurements are required. This can become a bottleneck in laboratory practice if numerous samples must be read. To use these values for setting up color correction

filter combinations is further time-consuming since the densities obtained must be correlated with the proper correction filter densities.

In the instrument to be described, a method is provided for determining very rapidly the correction filters necessary for printing a color film, assuming that all scenes will appear satisfactory when corrected to the same standard. It is recognized that any given standard, for example, gray, may not result in the most pleasing results for all scenes. Nevertheless, a gray balance condition as a first approximation is desirable, especially in color negative-color positive processes, since it will generally give the most acceptable overall quality, and is the best starting point for making changes if any are indicated.

The instrument is of most value for color negative-color positive processes, because in these processes it is difficult to estimate visually what correction filters are necessary from the color negative images. Color positive images can be evaluated fairly well by visual methods, but even here large errors are possible, especially if the color of the image deviates appreciably from normal.

Description of the Instrument

The principal errors in the color balance of a reproduction arise from:

1. Light source color-quality variations,
2. Film color-balance variations, and
3. Processing variations.

The combined effects of these can be measured from control densities placed on the film for this purpose. One or more gray values can be photographed at the beginning of each scene to establish the control density at or near the middle of the density scale of the film. For convenience we can assume that the reproduction of these gray values should be gray if the light source, film color balance and processing are normal. (This may not be true, however, for intermediate reproduction steps even

if gray reproduction has been accepted as normal for the final image.)

The problem, then, becomes one of determining whether or not the reproduction of gray is correct, and if not, expressing the deviation from gray in terms of correction filters required in printing to restore the gray condition.

Figure 1 is a schematic view of an instrument designed for this purpose. Its principle of operation is as follows: A standardized light source is focused upon the cathode of a multiplier phototube, the amplified output of which is connected across the vertical plates of a cathode-ray tube. In the light path immediately above the phototube is a rotating filter wheel containing three sectors. Each sector transmits but one narrow spectral band in the blue, green or red region. The filter combinations used to isolate these bands are the same as those in the original models of the Ansco Color Densitometer, giving transmission peaks at $440\text{ m}\mu$, $540\text{ m}\mu$ and $660\text{ m}\mu$ for the different filter sectors.² The rotation of the filter wheel is controllable from 300 to 900 rpm, but at any speed is synchronized with the horizontal sweep of the cathode-ray tube so that the first third of the tube pattern corresponds to the blue filter, the middle third to the green filter and the remaining third to the red filter.* Synchronization is accomplished by means of a small Alnico magnet on the periphery of the

* Numerous instruments have been described for various spectral analysis purposes which employ rotating filters or other wavelength isolation means in conjunction with a photocell and cathode-ray tube. An equivalent gray color densitometer having such components was described by Senger,³ Schneider⁴ and Schneider and Berger.⁵ Typical of electronic spectrographic equipment are the instruments of Feldt and Berkley,^{6,7} Dieke and Crosswhite⁸ and Sziklai and Schroeder.^{9,10} Zworykin and Ramberg¹¹ give a general discussion of the subject.

wheel. This forms an electrical impulse in a coil which is amplified and used to trigger the sweep of the cathode-ray tube.

The instrument is first balanced with a "type" sample in the light path by placing neutral densities in the filter sectors until a horizontal straight-line pattern is obtained on the cathode-ray tube. With this condition established, an off-gray sample substituted for the "type" will cause amplitude changes in the cathode-ray pattern depending upon the relative change it brings about in the amount of blue, green and red light reaching the phototube. For example, a sample deficient in magenta will allow an excess of green light to pass relative to the blue and red light transmitted. Therefore, the pattern on the cathode-ray tube will no longer be a horizontal straight line, but will rise principally in the middle section corresponding to the "green" position of the rotating

filter wheel. However, no part of the line image remains unaffected because the secondary absorptions of the magenta dye in the blue and red regions are also lacking.

Above the rotating filter wheel is a stack of three filter correction wheels, each having five openings. One opening in each wheel has no filter. This position, of course, is used when the instrument is balanced, or when an unknown sample is first placed in the light path. Different densities of yellow, magenta and cyan filters are in the other openings of the wheels, one color series in each wheel.* The dyes used

* Four filter densities and one blank in each of the correction filter wheels were found to be insufficient to meet all conditions in practice. Therefore, the instrument now has been revised to allow for several thousand filter combinations by adding three additional filter wheels, each having 14 apertures.

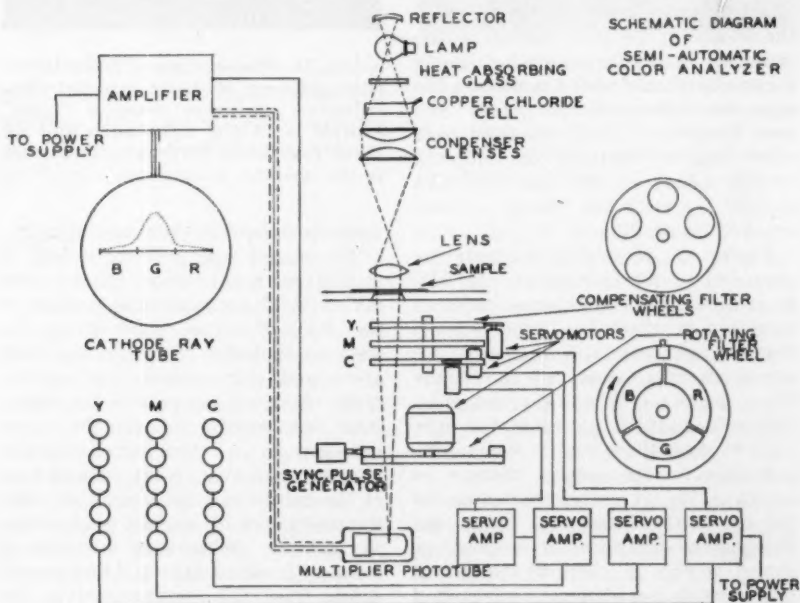


Fig. 1. Schematic view of semiautomatic color analyzer.

for these filters are the same as those which form in the layers of the color film.

The positioning of the various densities of the correction filters is accomplished by a servomechanism system, consisting of a series of pushbutton switches for each wheel, a synchro system, a servo amplifier and servomotor. When a given button is pushed down, the motor rapidly turns the wheel to place the correct filter in the light path as determined by the preset synchro system. The last button pushed down stays down so that the filters required for printing can be noted after balance has been established.

It is clear that yellow, magenta or cyan deficiencies of a sample can be ascertained by introducing the correction filters needed to restore a horizontal straight line on the cathode-ray tube. In the previous example, the magenta deficiency of the sample is compensated by use of a magenta filter of the required density. The hump in the middle of the tube pattern is flattened as increasing magenta density is introduced, and at the same time the apparent deficiencies in yellow and cyan disappear. For a color positive or color negative material the magenta density added in this case indicates directly the color and density of filter required for printing.

Figures 2a, 2b and 2c illustrate the operation of the instrument. In Fig. 2a is shown the straight-line, balanced condition in which the "type" sample is in the light path and all three of the correction filter wheels are in the no-filter position. When the magenta-deficient sample is placed in the light path in place of the "type" sample, the cathode-ray tube pattern changes as shown in Fig. 2b. By introducing the proper density magenta filter, the straight-line condition is restored, as shown in Fig. 2c. The fourth button in the middle row of buttons was pushed down to re-establish the balance of the

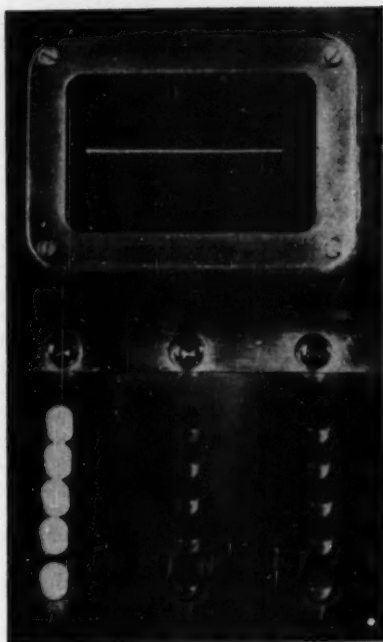


Fig. 2a. Photograph of cathode-ray tube pattern showing straight-line, balanced condition when a "type" sample is in the light path and all three correction filter wheels are set in the no-filter position.

instrument for this particular sample.

The control density of the sample to be analyzed is not critical, but it should fall along the straight-line portion of the $D\text{-log}_{10}E$ curves where it can be assumed that the curves for the blue, green and red densities are parallel. If the curves are not parallel the instrument will merely indicate the filters necessary to pull the curves together at one cross-over point. Parallelism of the curves can be ascertained with the instrument by use of a graded density sample. When such a sample is balanced for one density and then moved slowly from this density level to another, the cathode-ray pattern remains

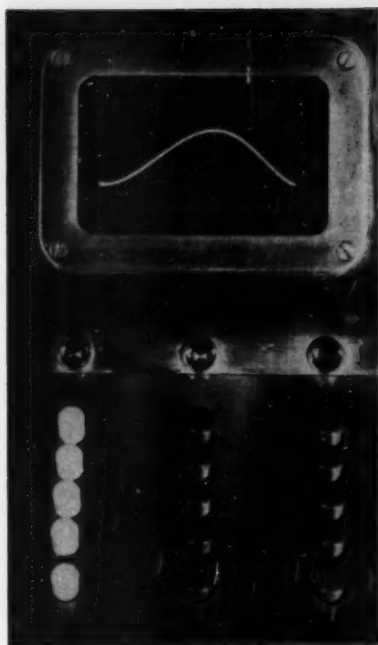


Fig. 2b. Photograph of cathode-ray tube pattern for a magenta-deficient sample. The central hump indicates the excessive green light transmitted by the sample.



Fig. 2c. Photograph of cathode-ray tube pattern for same sample as used for Fig. 2b, except a magenta correction filter has been introduced into the light path by pressing button indicated by arrow.

a straight-line if the curves are parallel. If the curves are not parallel, each change of density in the sample will require different balancing filters.

Figure 3 shows an over-all view of the instrument. The pushbuttons for positioning the correction filters, the cathode-ray tube screen and the aperture for placing the sample are in line, one above the other, with the cathode-ray tube placed at an angle for convenience in observing the pattern. At the sample position a sliding tube is provided to uncover the aperture for inserting the sample in the light path. When this tube is in the "up" position the aperture is illuminated from be-

neath so that the film density to be evaluated can be situated properly. The tube is then lowered over the sample to cut out extraneous light and to secure the film.

Figure 4 shows a close-up view of the control panel. The dials in the back are for presetting the synchro system so that the openings of the filter correction wheels fall in the light path. A standby switch is provided so that the power supply can remain on when the instrument is not in use. A speed adjustment for the rotating filter wheel is essential to obtain a smooth, steady trace on the cathode-ray screen. The usual cathode-ray tube controls are

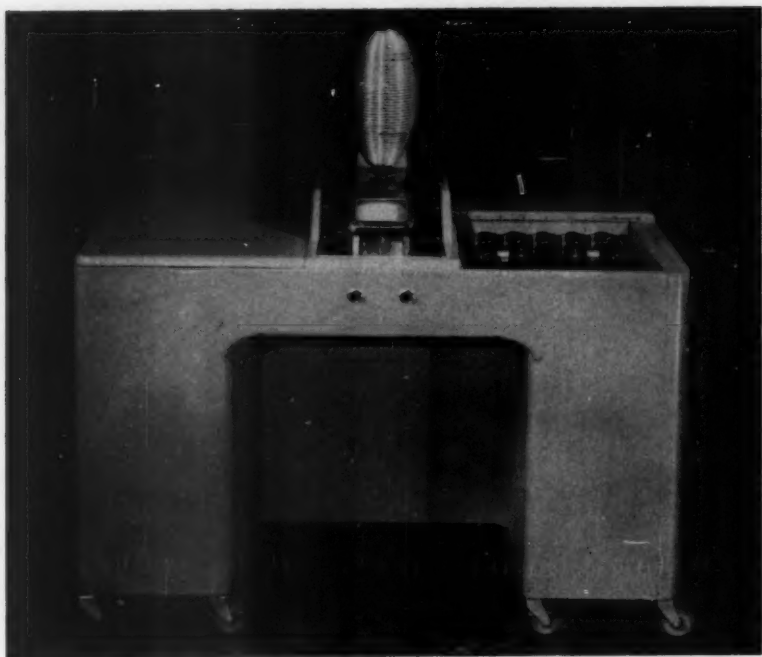


Fig. 3. Over-all view of color analyzer.

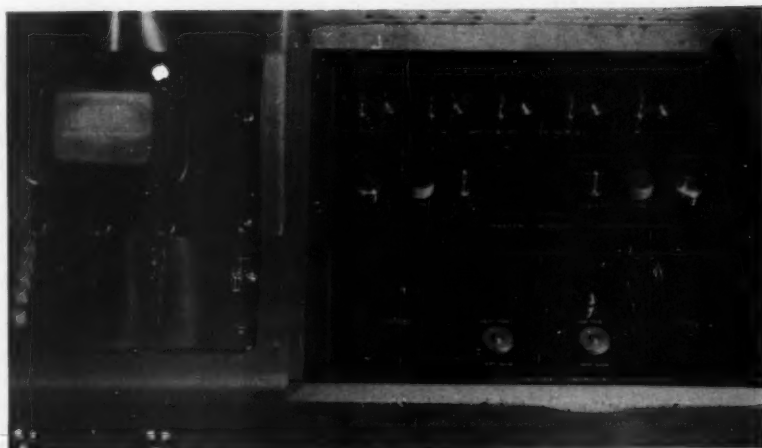


Fig. 4. Close-up view of control panel.



Fig. 5. Internal view of rotating filter mechanism, correction filter wheels, photomultiplier tube and servo amplifier units.

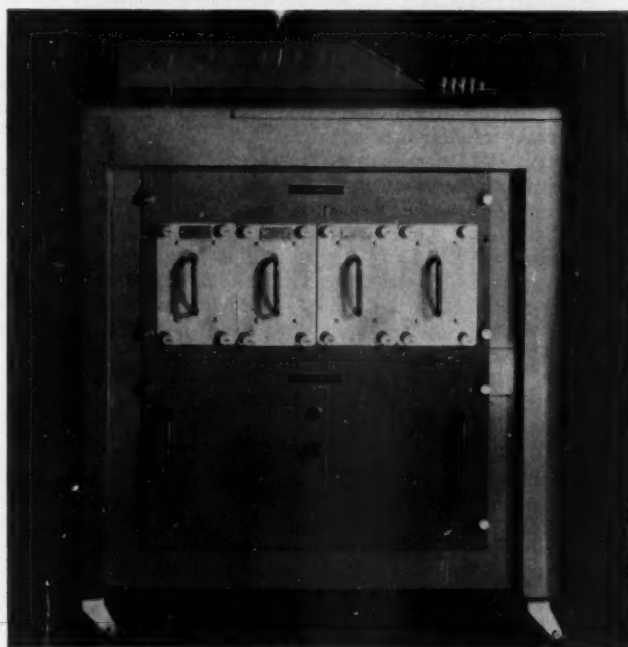


Fig. 6. View of one side of the color analyzer cabinet showing the readily removable electronic units.

also provided for positioning the trace in the center of the screen, for increasing or decreasing the brightness of the image, for focusing and for controlling the amplitude response. It is seldom necessary to use any of these controls once the instrument has been adjusted.

Figure 5 shows the internal mechanism of the filter correction wheels, the rotating filter wheel, the servomotors, etc. Also shown in Fig. 5 is an inside view of two of the servo amplifier units. These are standard units manufactured by Servomechanisms, Inc., Mineola, L.I., and are readily removable for inspection.

One side of the instrument is shown in Fig. 6 to illustrate how the electronic components are fitted into the cabinet for convenient servicing.

Acknowledgments: The following people have given valuable assistance in the final design, construction or testing of the instrument: Dr. Herman Duerr, Monroe H. Sweet and John Forrest of Ansco; William Shannon and Ralph Redemske of Servomechanisms, Inc.; Leo Pavelle, Peter Krause and Rudy Seefried of Pavelle Color Inc.

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Motion Picture Studio Lighting Committee Report

By M. A. Hankins, Committee Chairman

During the past several years the Motion Picture Studio Lighting Committee reports and papers have described studio lighting equipment, set power distribution and power supply.¹⁻⁴ Some mention has been made of set lighting levels and lamp location but the variables are so great it was found exceedingly difficult to provide the information within the scope of a paper or report.

Because of numerous requests for at least a general picture of set lighting levels and equipment placement, this report will describe and illustrate representative sets which were lighted for three-color photography and come within what may be termed as "high-key" lighting.

IN SET LIGHTING for motion pictures the cinematographer thinks more in terms of obtaining an emotional effect that will carry the mood of the picture to the audience than upon correct exposure alone. If he must make a choice between working within the normal latitude of the film or obtaining the best dramatic effect, he will usually choose the latter course. Whether or not his result is satisfactory is a measure of his combination of artistic and engineering ability.

From an engineering viewpoint he may find it desirable to establish his key-light in the middle range of the latitude of the film and to restrict high-light and shadow areas to a ratio that will assure correct exposure. From an artistic viewpoint, however, he may not be able to obtain the dramatic effect for which he is striving and he will experiment outside of engineering limits

for the best combination of exposure and dramatic effect.

The key-light levels on the color sets described vary from 500 to 600 ft-c. While there may be instances of sets which are photographed at higher levels than those indicated, for the most part the trend would be downward, even toward key-light levels as low as 50 ft-c on some gangster, or mystery type, black-and-white pictures.

A study of the following data will cause some to wonder why a set is rigged with more lamps than the total operating load indicates as having been used. The question is answered by the fact that when the cinematographer starts shooting he must have lamps in place for long shots, medium shots, dolly shots, and close-ups to avoid the necessity of the loss of expensive shooting time in moving lamps.

Quite often the cinematographer sees a given set for the first time shortly before he starts to photograph the picture. He has had little to do with the shooting arrangement, color balance

Presented on October 19, 1950, at the Society's Convention at Lake Placid, N.Y.

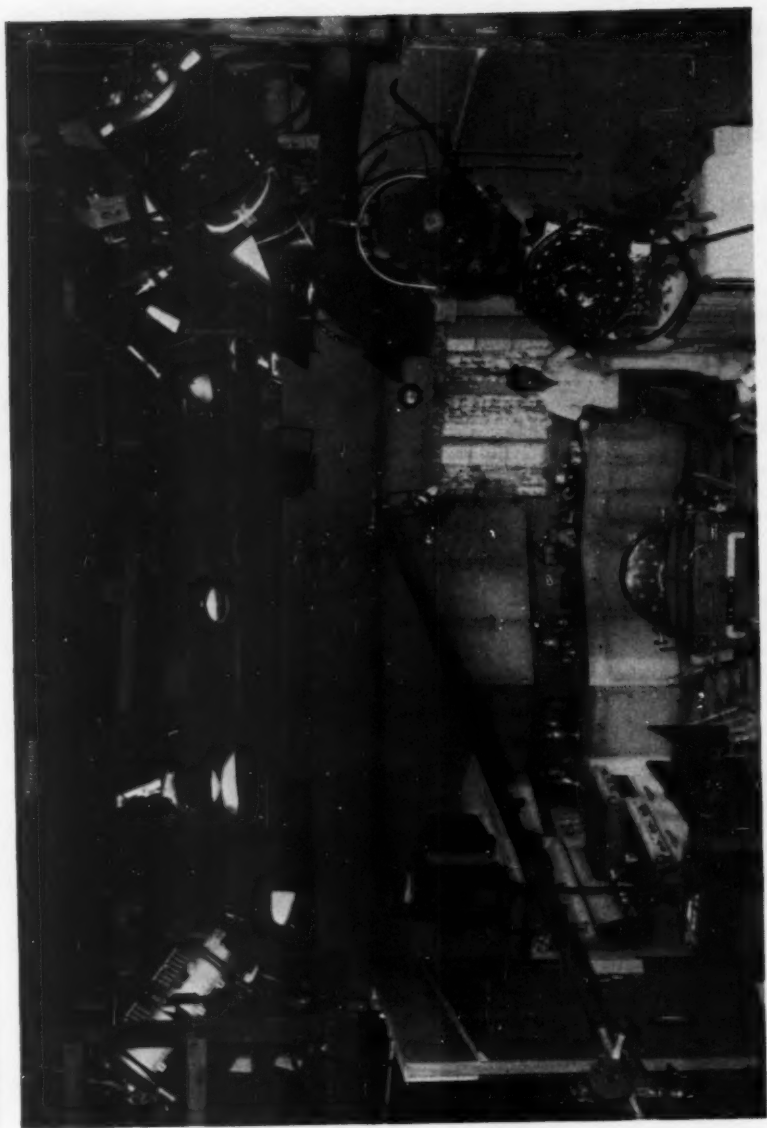


Fig. 1. Lighting arrangement of butler's pantry scene in *Lullaby of Broadway*.
Courtesy of Electrical Dept., Warner Bros. Pictures, Inc.

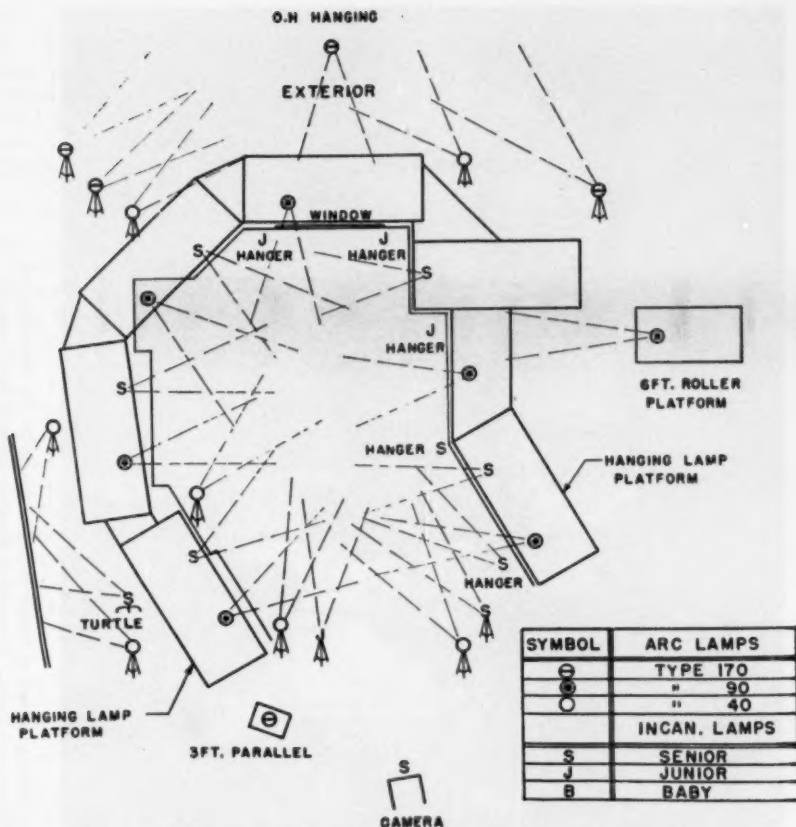


Fig. 2. Gaffer's layout of butler's pantry scene in *Lullaby of Broadway*. Courtesy of Electrical Dept., Warner Bros. Pictures, Inc.

or general preplanning, yet he must be in a position to establish and maintain key-light levels on characters who are moving about, and often with the camera in movement on a dolly as well. Furthermore, even after shooting has started, he is often called upon to rearrange his lighting for a different camera angle than was originally planned.

It would seem, if the latitude of the particular color process is to be sacrificed for dramatic effect, there would be little hope of expecting the optimum

in color quality. In actual practice the reverse is true because color quality has been steadily improving in the face of fewer restrictions placed upon the cinematographer and of lower light levels being used. It is merely a case where the end result is *dramatic effect* and engineering ability is being applied to make the process meet the needs of the end result rather than the apparent exposure requirements of the film alone.

It is a virtual impossibility to establish hard and fast rules and regulations for



Fig. 3a. Lighting arrangement of home interior scene in *On the Riviera*.
Courtesy of Electrical Dept., Twentieth Century-Fox Film Corp.

the lighting of a given motion picture set since each cinematographer will light a set to satisfy his individual artistic interpretation of the dramatic effect he is striving to produce. However, in order to indicate general set-lighting requirements, a survey was made of three motion picture sets in production: a small set, one of medium size and a large one. Information concerning how these representative sets were lighted for three-color photography is contained in Table I.

A study of Table I shows that while the area of the set in *Lullaby of Broadway*, Figs. 1 and 2, was only half of that in *Home on the Riviera*, Figs. 3a, 3b and 4, the total peak load was almost the same. This may be accounted for by the actual area being illuminated on the set, by the type of lamps needed for the particular effect and by the mood of the effect itself. In Figs. 1 and 2 a higher key-light level is maintained than on the scene shown

in Figs. 3a, 3b and 4. However, less light is needed on the walls to bring them into proper perspective with the balance of the scene. Also, in Figs. 1 and 2 the shadow areas are illuminated, whereas in Figs. 3a, 3b and 4 they are allowed to go black.

The *Samson and Delilah* set, illustrated in Figs. 5 and 6, shows the lighting equipment used on large areas where daylight intensity is indicated. It is interesting to note that the high light-to-shadow ratio was maintained within narrower limits than on the other sets illustrated.

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(concluded on p. 211)

Table I. Data on the Lighting for Three-Color Photography of Representative Motion Picture Sets of Small, Medium and Large Size.

	<i>Lullaby of Broadway</i>	<i>On the Riviera</i>	<i>Samson and Delilah</i>
Scene	Butler's Pantry	Home Interior	Temple of Dagon
Width of set, ft	16	25	75
Length of set, ft	28	40	265
Area of set, sq ft	448	1000	19,875
Height of lamp parallels, ft	14	13	25, 30 & 34
Color of walls	light blue-green	tan	grayish yellow
Key-light level, ft-c	600	500	550
Average light level on walls, ft-c	200	300	500
Min. light level in shadow area, ft-c	50	approx. zero	100
Max. highlight level, ft-c	600	500	550
Camera lens diaphragm opening	f/2.2	f/2.2	f/1.9
Type and number of arc lamps	Type 450		30
available on set	Type 170 6 Type 90 11 Type 40 15	7 12 14	232 42 40
Type and number of incandescent lamps	Senior 16 Junior 13 Baby 15	40 21 12	14
available on set	Sky Pan		24
Total paper load, amp	3985	5550	57,090*
Peak load used, amp	2450	2860	48,000
Photographs of set	Fig. 1	Figs. 3a and 3b	Fig. 5
Gaffer's layout sketch	Fig. 2	Fig. 4	Fig. 6

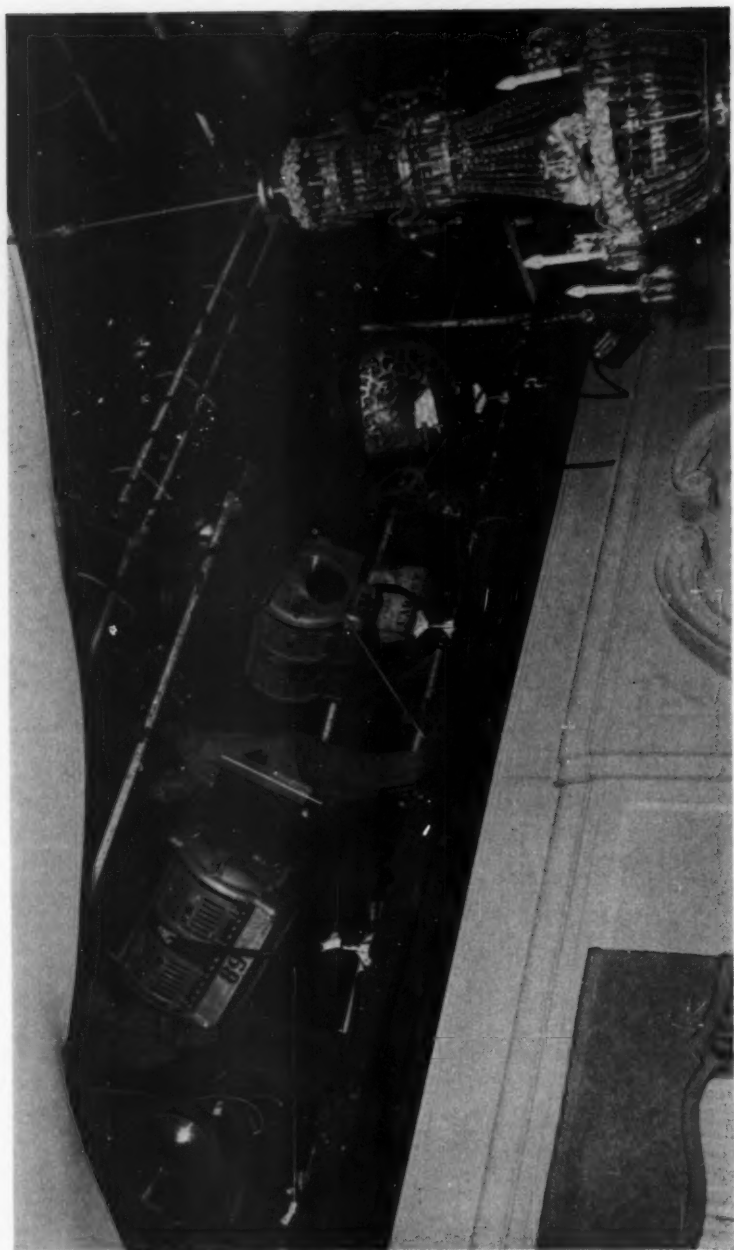


Fig. 3b. Positions of lamps and control devices for home interior scene in *On the Riviera*.
Courtesy of Electrical Dept., Twentieth Century-Fox Film Corp.

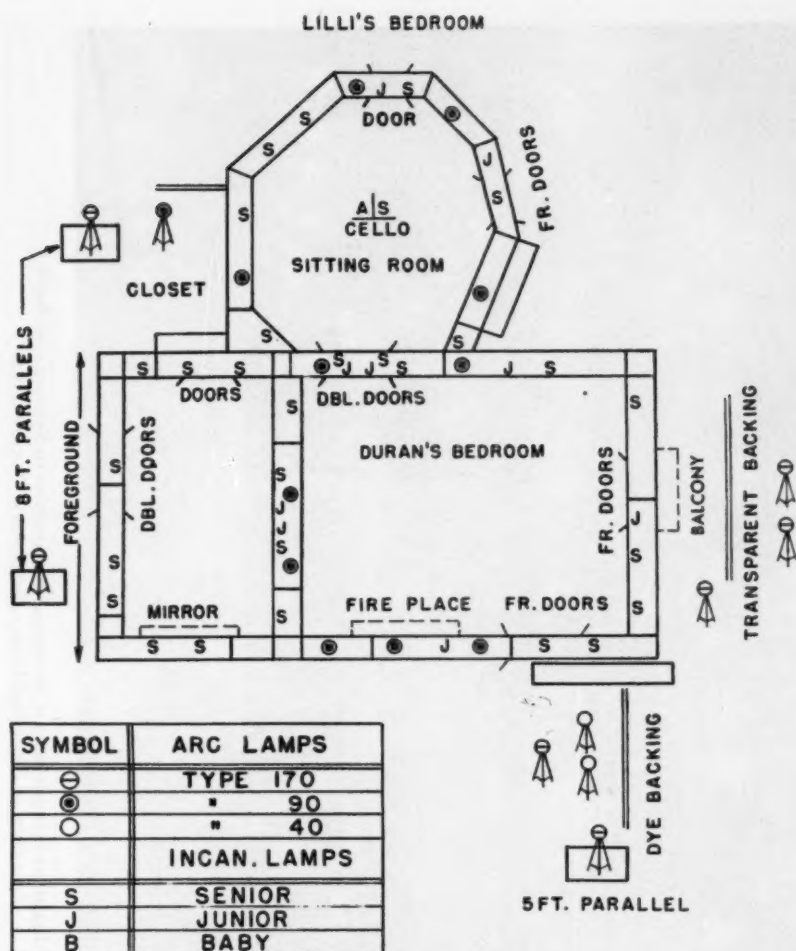


Fig. 4. Gaffer's layout of home interior scene in *On the Riviera*.
Courtesy of Electrical Dept., Twentieth Century-Fox Film Corp.

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- Committee Members**
- | | |
|----------------|---------------|
| Richard Blount | Petro Vlahos |
| J. W. Boyle | C. R. Long |
| Karl Freund | W. W. Lozier |
| C. W. Handley | D. W. Prideux |

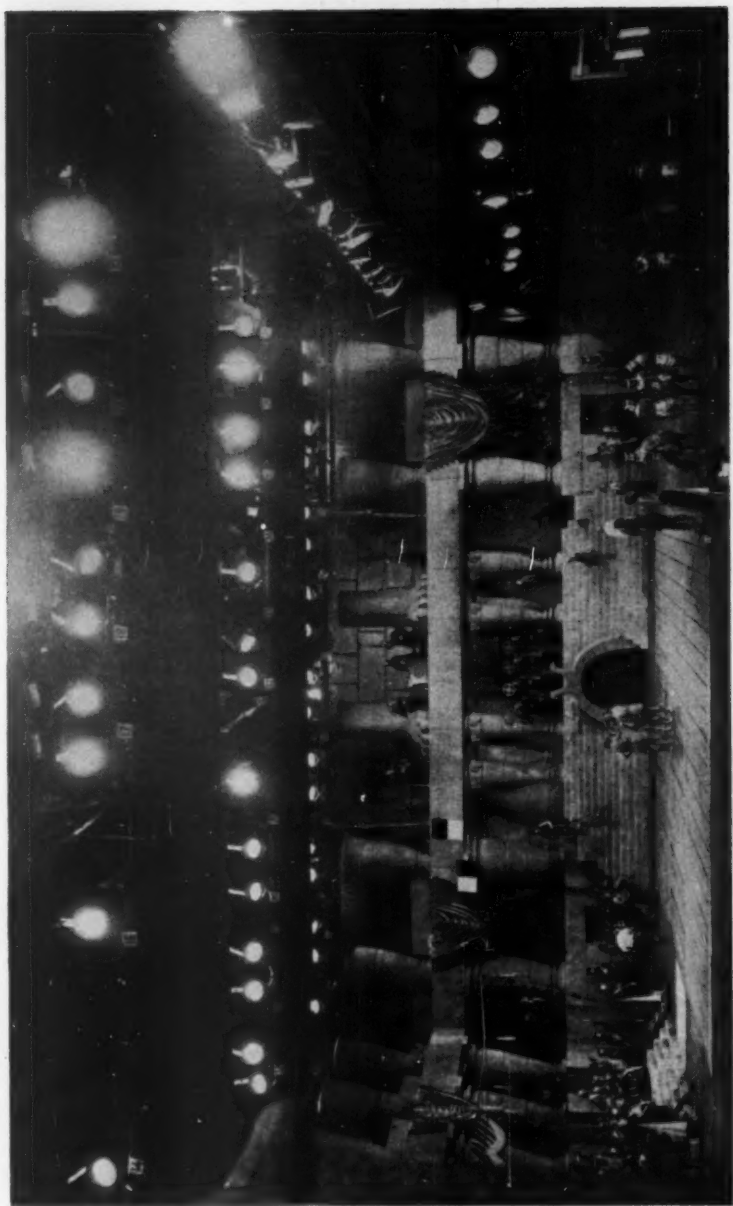


Fig. 5. Lighting arrangement of Temple of Dagon scene in *Samson and Delilah*.
Courtesy of Electrical Dept., Paramount Pictures, Inc.

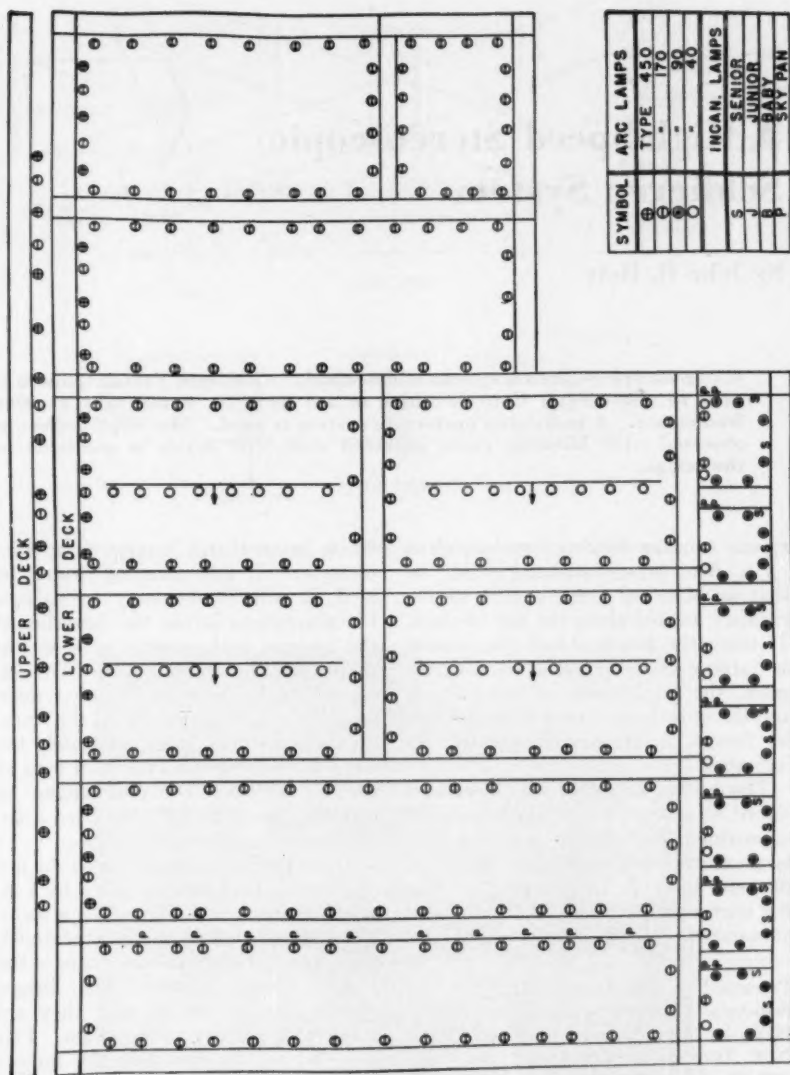


Fig. 6. Gaffer's layout of Temple of Dagon scene in *Samson and Delilah*.
Courtesy of Electrical Dept., Paramount Pictures, Inc.

A High-Speed Stereoscopic Schlieren System

By John H. Hett

A stereoscope Schlieren system is described. A 16-mm Fastax Camera is used to photograph 10-in. sections of a 4 by 4 in. flame tube at 9000 frames/sec. A polarizing projection system is used. The depth effect is observed with burning gases provided sufficient detail is available in the image.

THE NORMAL Schlieren system gives a flat two-dimensional field, so that an observed event cannot be accurately located along the line of sight. To study the details of such phenomena as burning jet formation in combustible gases, the acceleration of flame fronts and the growth and decay of turbulence in flames, a stereoscopic system is indicated.

The system shown in Fig. 1 was designed to observe a working section of approximately 5 by 10 in. The two large mirrors are parabolae 16 in. in diameter by 60 in. in focal length. The flat mirrors, *A*, are 6 in. by 10 in., front aluminized. These mirrors should be

flat to better than 2 bands over an 8-in. diameter. If this accuracy cannot be held, it will be necessary to balance the aberrations in the two branches of the system, and possibly give special shapes to the knife edges. The included angle between the two main branches was chosen as 15° at the working section, which is approximately the angle of convergence of normal eyes at reading distance. Higher angles of convergence up to 35° were tried without improving the performance.

This system is usually used to observe 10-in. long sections of a 4 by 4 in. square flame tube. Figure 2 is a photo of the system. Two images are formed, one above the other on each frame of the Fastax 16-mm camera. The images on the film are set so that they are about 1 mm apart at the edges. Figures 3a and 3b show how the images appear on the film. Figure 4 shows the test hexagon.

The light source used is a 100-w zirconium lamp with a horizontal cylindrical condenser. The two knife edges are also horizontal, that is, in the plane of the axis of the flame tube; each knife

Presented on October 18, 1950, at the Society's Convention at Lake Placid, N.Y., by John H. Hett, Research Div., New York University College of Engineering, University Heights, New York 53, N.Y. The work described in this paper was done with the support of the Office of Naval Research, Dept. of the Navy, and the Office of Air Research, Dept. of the Air Force, under Contract N6ori-11, Task Order 2, as part of Project Squid.

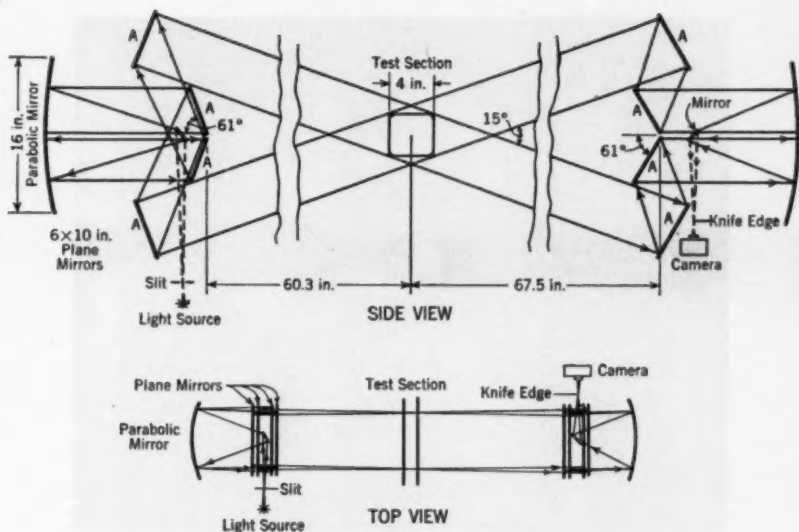


Fig. 1. General ray system for stereoscopic Schlieren.

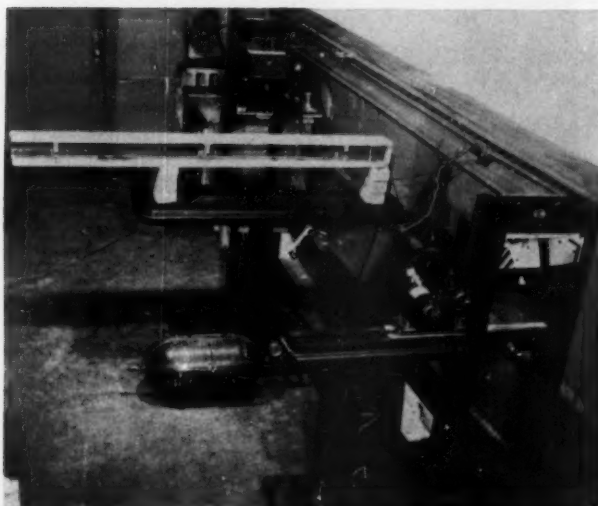


Fig. 2. Photo of the system from camera end, showing 6-ft flame tube in position.

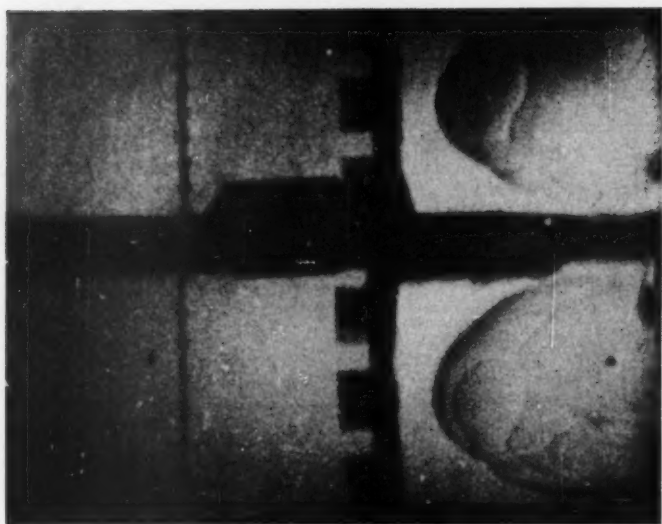


Fig. 3a. Stereo pictures of flame front about 25 msec after spark ignition of stoichiometric mixture of propane-air in flame tube. The heavy black transverse image is a 3-hole grid placed across the tube.

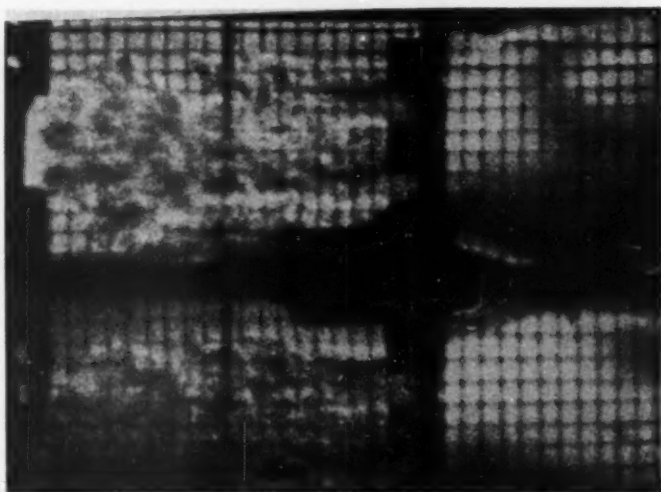


Fig. 3b. The turbulent flame after passing through the grid. The wire mesh was added as a reference frame behind the back surface of the tube.

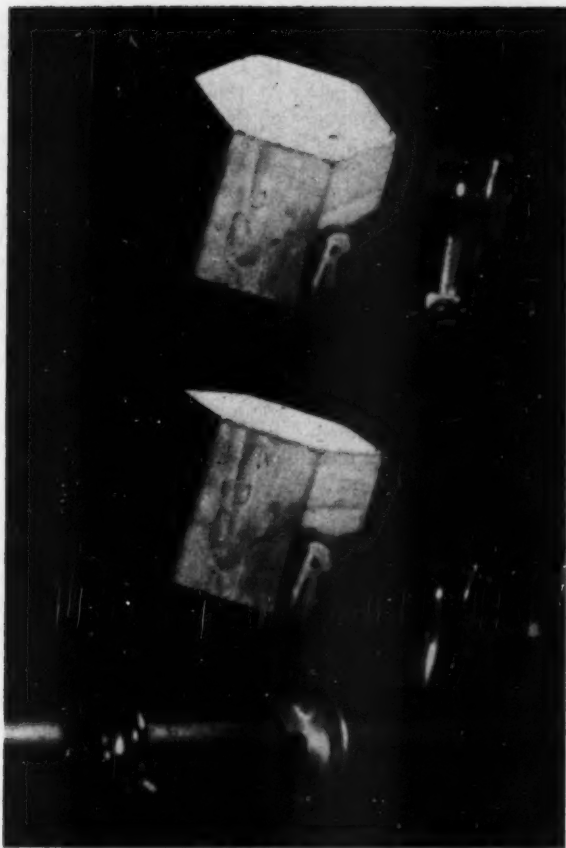


Fig. 4. The two images of the test hexagon. These can be rotated at high speed.

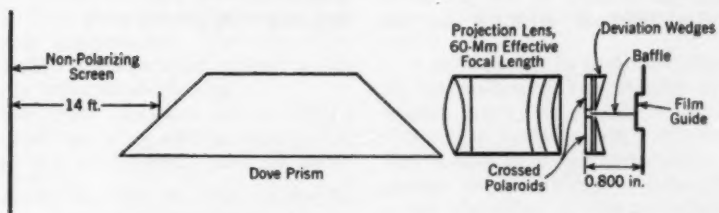


Fig. 5. The projection system. The Dove prism is rotated until the images are vertical on the screen.

edge cuts the ray bundle from the bottom. The illumination is sufficient in this system to operate the Fastax camera at 9000 frames/sec, using Linagraph film. Attempts to use the system with Kodachrome film at 500 frames/sec were unsuccessful. In adjusting the system before exposure it was found necessary to view the film directly rather than use the regular Fastax viewer, because the relative aperture of the viewer is smaller than that of the camera lens, thus vignetting some of the rays.

The projector is a Bell & Howell Diplomat, Model A, modified as follows: A two diopter negative lens is combined with the regular 50-mm projection lens to obtain a longer back focal length. Between the lens and the film gate two wedges are mounted as shown in Fig. 5. Also, two crossed polaroids are mounted in front of the wedges and a baffle is placed to isolate each field. A Dove prism is placed in front of the projection lens at such an angle that the images of the flame tube appear vertical on the screen. This is necessary since the observer can see only stereoscopically in the horizontal plane through the eyes. A throw distance of 14 ft is used to a nonpolarizing screen. The observer wears crossed polaroid lenses.

For successful operation of this system, the following points should be carefully considered:

1. Screen registration: This involves careful setting of the images in the Fastax, particularly in the horizontal direction (vertical direction on the

screen). It is desirable to use fine wires in the object field and set them to within 0.002 in. in the image field. At the projector, the deviation angle of the prisms, focal length of projection lens and throw distance are all related quantities and should be carefully adjusted.

2. Care should be taken to avoid image jump on the screen. Even though the images may jump together, this causes difficulty in stereoscopic fusing.

For more precise analysis, prints may be made from the film and viewed with a conventional Wheatstone stereoscope using magnification.

Observational Results

The system was tested by using opaque objects such as the hexagonal cylinder which was rotated at high speed. Completely satisfactory pictures were obtained.

Some loss of the depth effect is encountered in viewing symmetrical smooth flame surfaces, as for example, the spherical wave leaving the spark ignition point of Fig. 3a. This effect is probably due to high transparency and lack of contrast.

In turbulent flames or turbulent hot gases, the stereoscopic effect is achieved. If one knows the true scale of the object field, it is possible to locate events along the line of sight, and also determine directions of rotation of the gases.

The author wishes to acknowledge the assistance of R. J. Kraushaar and S. Braunstein with much of the construction and experimental work.

Some Commercial Aspects of a New 16-Mm Intermediate Film Television System

By Raymond L. Garman and Blair Foulds

Theater television requires picture quality comparable to that attained in feature film releases, and flexibility in program scheduling comparable to television broadcasting. A new 16-mm intermediate film system designed for these requirements is described. The system includes video recording equipment for pickup of coaxial-line or broadcast programs, high-intensity film projection equipment, and an automatic rapid film processor. The use of the rapid film processor is discussed in connection with delay techniques for adequate program scheduling. General operating characteristics are analyzed in terms of economics of the system.

INTEREST in theater television has been growing for a number of years. The past year has seen considerable activity in equipment development along two main lines. One has been the development of 35-mm film delay methods; the other has been the development of better cathode-ray tubes for use with Schmidt optical systems in direct projection.

The 35-mm film delay system has been recognized from the beginning as one which is capable of providing high quality performance. The cost of installation and operation of such a system is understandably high.

The direct projection system offers a possible operating cost advantage but does not, at present, meet all neces-

sary performance requirements. It provides only a marginal amount of light. Additionally, operation of the cathode-ray tube at or near maximum light level is usually accompanied by poor definition in the highlights. The extremely high voltage required by the cathode-ray tube (50 to 80 kv in 1949 practice, with higher voltages in prospect) has been difficult to contain within the equipment and can be expected to result in some erratic component failures unless extreme precautions are taken.

A third system is under development in Switzerland. The details of this system, known as the AFIF Television Projection System,¹ were reported to this Society at its last convention. The system is intermediate in principle between the delay or film recording system and the direct system. It combines some of the features of both systems. Whether or not the system of-

Presented on April 25, 1950, at the Society's Convention at Chicago, Ill., by Raymond L. Garman and Blair Foulds, General Precision Laboratory, Inc., Pleasantville, N. Y.

fers promise for the future remains to be seen.

While these developments have been in progress, a new system has been quietly reaching maturity. This system stems from the 16-mm video recording field, which was an infant in the professional sense a little more than a year ago, and now uses more 16-mm film than all other professional and amateur services combined. The quality of the film produced by video recording has been steadily improved so that today it can be said that if professional equipment is used throughout, from program reception to film projection, theater quality can be attained. The 16-mm film size provides some noteworthy advantages. Cost is considerably reduced over comparable 35-mm systems, and the final product is more easily handled, shipped and stored. A 16-mm video recording system similar to that used in television studios can be engineered for theater service, thus providing an intermediate-film television system. To be successful, however, such a system must be designed for the specific commercial requirements of theater presentation.

System Considerations

Commercial use in theaters calls for quality equipment throughout. Conversion from the television standard rate of 30 frames/sec to the 24-frame/sec rate of the motion picture industry must be performed by a thoroughly reliable method. Particular care is required in design of the many camera and projector details in order to realize fully the resolution capabilities of 16-mm film. Operation must be almost entirely automatic, not only to keep the amount and types of skilled labor to a minimum but also to assure a steady flow of high quality product. Components must be as compact as possible to permit installation within the limited space available in our present day motion picture houses, without occa-

sioning extremely high installation costs. Splicing and editing facilities are needed to allow for insertion of special trailers, titles and show announcements, and to contribute generally to the over-all aspect of showmanship. Processing units must be designed so as to require the minimum amount of chemicals in storage, because of the frequent shutdowns which may be required for program scheduling. The projector itself must be capable of providing adequate light for even the largest motion picture houses and of fully utilizing the performance possibilities of correctly recorded and processed 16-mm sound track. Maintenance cost must be low, and complicated maintenance operations must be avoided wherever possible. In order to meet these severe commercial requirements, new concepts have to be introduced in many or all phases of the art.

Physical Requirements

A better insight into some of the problems can be gained by reviewing the physical requirements of the various units which comprise a complete theater installation. A typical installation, shown in skeleton form in Fig. 1, has terminal facilities for either off-the-air or coaxial-line pickup. The video portion of the program is photographed on 16-mm film from the face of the recording cathode-ray tube, and the accompanying sound is recorded simultaneously on the film sound track. Exposed film from the camera feeds into the rapid film processor and emerges as a dry, waxed print, ready for projection in the special new 16-mm projector designed for the purpose.

The antenna array is the starting point of the system. For theater use, the antenna must provide noise-free operation, freedom from ghosts, and extremely steady signals. This can be achieved by careful selection of the antenna for reception from a particular station or by the use of multiple an-

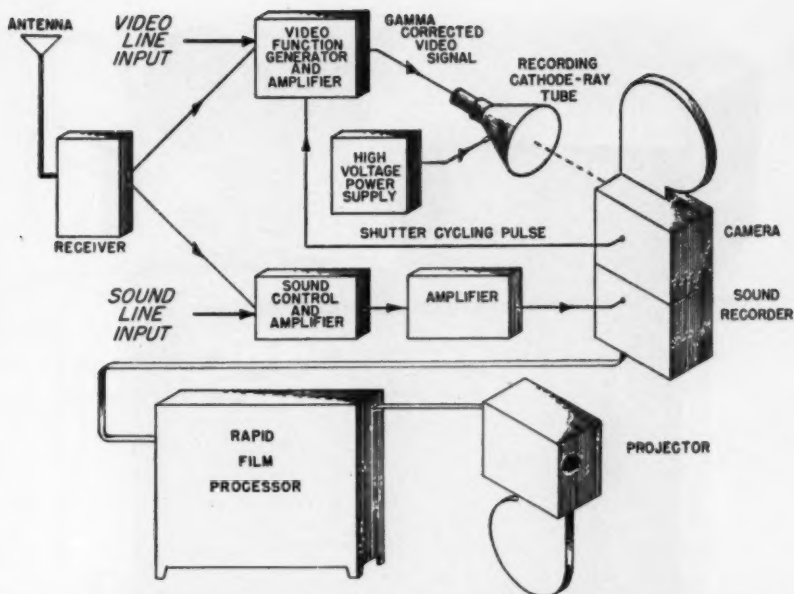


Fig. 1. Block diagram of a 16-mm intermediate film theater television system.

tennas or rotatable antennas if several stations are to be received under severe conditions.

The receiver must be reliable and stable in operation, easy to tune, and simple to maintain. A receiver which provides the necessary reliability and stability has been developed, and it has been described elsewhere in this JOURNAL.² By use of remote controls, the receiver unit can be placed in some relatively inaccessible part of the projection booth, or even in some other part of the theater.

Programs can be taken from the receiver or from separate video and sound line inputs. In either case, the video portion of the program feeds into a block which we choose to call the "Video Function Generator." This block consists entirely of electronic circuit elements which perform the various tasks required for conversion of a composite video signal into a picture suitable for

photography. It performs the frame-rate conversion from television standard rate of 30 frames/sec to the motion picture standard rate of 24 frames/sec. It provides a gray-range, or gamma correction, and contains control and monitoring facilities. This block can, in fact, be regarded as the heart of the system.

Several blocks, including the video function generator, the 30-kv high-voltage power supply, the recording cathode-ray tube, the camera and the sound circuits are all contained in a single Video Recorder Unit.³ The unit, shown in Fig. 2, is slightly more than 5 ft wide, and stands 6 ft high to the top of the reel housing. It should be mentioned that, although a double reel housing is shown, only the feed side is used. The reel housing has a 1200-ft capacity, which is equivalent to 33 min of continuous running time. A larger reel housing which holds as much as



Fig. 2. Video recorder.

4000 ft of film can be installed in place of the 1200-ft one. The hood at the left conceals the recording cathode-ray tube. The electronic circuits associated with the video function generator are contained in the base.

The gray-scale or gamma correction circuit enables a considerable improvement in picture quality over that obtained in an uncorrected system. A gamma of between 1.5 and 1.7 is generally considered to give the most pleasing picture for motion picture exhibition by direct projection. The gamma value actually obtained depends on the over-all transfer characteristic of the system elements which intervene between the scene and the print. Any system element having a nonlinear

transfer characteristic affects the gamma value. Amplifying and detecting elements which are commonly used have linear transfer characteristics, but many of the currently available light-to-signal and signal-to-light transducers are inherently nonlinear. Picture contrast in present television practice approaches that of a high-gamma print, due to the nonlinear transfer characteristics of the camera pickup tube and the recording cathode-ray tube. The film itself further increases the final gamma value so that the cumulative effect in an uncorrected system is a higher gamma value than desired. The correction circuit, a nonlinear amplifier with an adjustable characteristic of the type required to reduce print

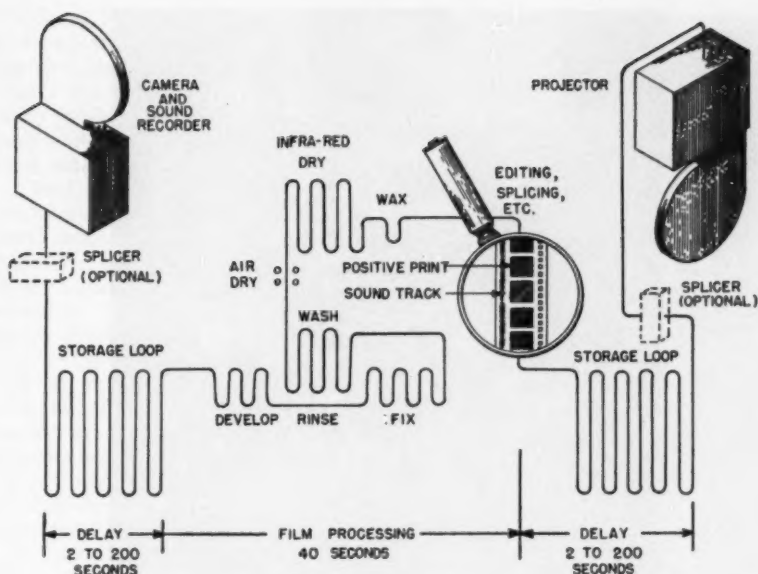


Fig. 3. Film path.

gamma, can be controlled as required to produce an optimum print.

The remaining portion of the video function generator is devoted to the frame rate conversion circuits. The operation of these circuits is based on the fact that each television frame contains exactly 525 horizontal scanning lines. Electronic counting circuits are therefore used to time the film exposure. The operation is as follows:

Film exposure may start at any horizontal scanning line of the television image. Once started, the exposure continues until exactly 525 lines have been counted out. The circuits then blank the recording cathode-ray tube and stop the exposure.

In the camera, film pulldown starts after exposure stops. At the end of $\frac{1}{24}$ sec, both the exposure and film pulldown have been completed. The camera then delivers a cycling pulse which starts a new cycle. Photography is thus performed at a rate of 24 frames/

sec, that is, at the rate established by the film camera. A complete television frame is photographed for each film frame, even at rates considerably below 24 frames if required.

The camera has a sufficiently fast pulldown to operate within $\frac{1}{120}$ sec, which is the time interval between the end of the television frame and the start of the next film frame exposure. On the other hand, the camera need not have the usual mechanical shutter. The counter circuits, in effect, form an electronic shutter which has a much greater timing accuracy than a mechanical shutter.

The recording cathode-ray tube presents a negative picture to the camera. Reversal introduced by subsequent processing results in a positive print. The cathode-ray tube operates at about 25 kv, which is considerably less than that required in the direct projection system. This voltage must, however, be closely maintained. In other words,

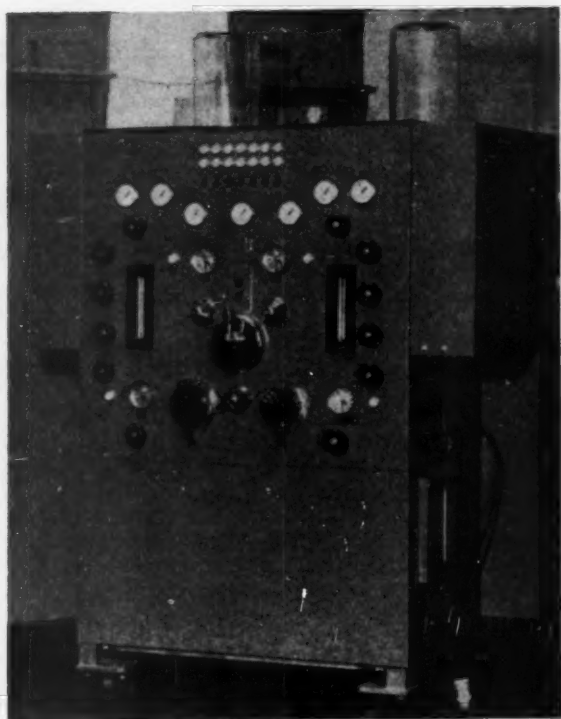


Fig. 4. Rapid film processor.

a "stiff" power supply is needed. Otherwise, the change in beam current due to differences in average scene brightness would cause corresponding changes in both picture size and focus adjustments.

The audio side of the system can and should achieve better than average sound quality. Since playback is from the same film original as that on which the recording is made, only a single recording and playback operation is required. Further, the entire process can be controlled within the theater. If the recording is good, the reproduction can be correspondingly good.

The sound recording head in the system described is one which was

developed by J. A. Maurer, Inc. Response is essentially flat to 9 kc. Recordings are high-level variable-density, corrected for both the toe and shoulder of the H&D curve. An intermodulation figure of 6% is obtained, which is comparable with that of the best double-film toe recordings. A network matches the recording characteristic to the playback characteristic of the reproducer. The G.P.L. projector sound head is designed to match the frequency range of the recording head.

The problem of handling the exposed film after it leaves the camera introduces several requirements. Splicing facilities are needed to allow insertion of fill-ins, trailers, titles, and

processing leader, and to permit camera and projector changeover. Film storage facilities are needed to allow any one of the units to be stopped separately while the other units are running. These features are shown in more detailed form in Fig. 3.

Two types of film storage racks are available. One, the larger, has a maximum delay capacity of about 3 min. The other, the smaller, has a maximum delay capacity of about 10 sec and assembles directly to the side of the Rapid Film Processor.⁴ The storage loop in the smaller rack is sufficiently long to avoid possible film breakage when adjacent units are simultaneously started or stopped. The larger rack provides sufficient delay for most splicing and editing operations. Racks can be combined for additional delay, if necessary.

A particular advantage of 16-mm film is that it permits the use of relatively compact equipment for film handling and processing. The Rapid Film Processor is only 5 ft high and approximately 3 ft wide (Fig. 4). The larger film storage rack, which contains sufficient footage for 3 min. of running time, occupies a space about 1 ft wide by 6 ft high. It is reasonable to assume that space for these components can be found in or adjacent to most projection booths.

The use of 16-mm film in theaters has previously been limited by the lack of projectors with sufficient light output for the purpose. An arc lamp projector has therefore been developed and made available for theater use. The standard 16-mm arc lamp projector (Fig. 5) provides 2000 total screen lumens when used with an $f/1.6$ lens. With special carbons and feed methods, it may be possible to obtain as much as 3200 total screen lumens. The illumination and screen brightness figures for both types of carbons are shown in Table I. The figures are stated on the basis of shutter running

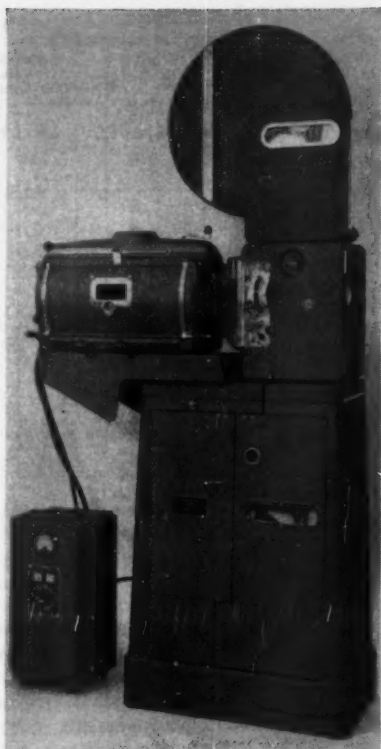


Fig. 5. 16-Mm arc lamp projector.

and no film in the gate. The acceptable screen brightness by SMPTE standards, on this same basis, is 9 to 14 foot-Lamberts. It is therefore apparent that illumination is adequate for even fairly large houses. The illumination figures shown may seem surprisingly high for the film size used. However, the average shutter efficiency of 35-mm projectors is in the order of 50%, while the shutter efficiency of the particular 16-mm projector described is 73%. In addition, a larger lens aperture is used with this projector than is commonly used in 35-mm machines.

In regard to operating costs, 16-mm film offers an appreciable advantage

Table I. Arc Lamp Projector Performance

Throw Distance, in feet		Picture Width, in feet	Standard Arc Lamp for 16-Mm Projector 2000 Total Screen Lumens*			Special Arc Lamp for 16-Mm Projector 3200 Total Screen Lumens*		
			Illumina- tion, foot- candles	Screen Brightness, foot-Lamberts		Illumina- tion, foot- candles	Screen Brightness, foot-Lamberts	
4-In. F.L. Lens	2-In. F.L. Lens			Matte Screen	Beaded Screen†		Matte Screen	Beaded Screen
80	40	7.5	47	38	277	76	61	443
100	50	9.5	30	24	175	48	39	281
120	60	11.4	21	17	121	33	27	193
140	70	13.2	15	12	90	25	20	143
160	80	15.2	11	9.1	66	18	15	106
180	90	17.1	9.3	7.5	55	15	12	87
200	100	19.0	7.3	5.9	43	12	9.4	69
220	110	21.0	6.1	4.9	35	9.7	7.8	57
240	120	22.8	5.1	4.1	30	8.2	6.6	48
260	130	24.6	4.4	3.5	26	7.0	5.7	41
280	140	26.6	3.8	3.1	22	6.1	4.9	36
300	150	28.5	3.3	2.6	19	5.2	4.2	31
340	170	32.4	2.5	2.0	15	4.1	3.3	24
400	200	38.0	1.9	1.5	11	3.0	2.4	17

* With shutter running, no film in machine.

† When viewed in the direction of the projected beam. When viewed 10° from the projected beam direction, the values are 40% of those listed.

over 35-mm film. Current film prices for fine grain release positives on safety stock are \$17.20 per hour for 16-mm film, as against \$80.00 per hour for 35-mm film. Other operating costs can also be expected to be lower, but not necessarily in as high a ratio, nor can exact evaluations be made. Chemical costs should be lower with 16-mm film. The greater compactness of 16-mm equipment, and the smaller floor space requirement, may allow a saving in new theater construction cost or, alternately, an increase in useful seating capacity. The life expectancy of 16-mm equipment which is designed for professional use is as high as, or higher than, that of 35-mm equipment. The projector operates at the same frame rate in either case and can therefore be assumed to have the same life expectancy; the processor, operating at a lower film travel rate, can be assumed to have a greater life expectancy. Due to the ease of handling 16-mm film, labor costs may be somewhat lower.

Conclusion

All of the components for intermediate film theater television using 16-mm film size are currently available. This film size offers important cost economies in both hourly operation and initial installations. Delay techniques permit flexibility in program scheduling. Picture quality and screen brightness are entirely satisfactory for theater use.

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Television Film Recording and Editing

By Albert Abramson

This paper reviews the uses of television film recording and the possibilities of applying the editing principle to it.

THERE IS A NEED in television for a flexibility and perfection that cannot be attained by using live television techniques. The means for meeting this need lie within the scope of any television station equipped to record television programs on film. But today's methods of television film recording must be improved both filmically and technically.

Cathode-ray photography dates back to 1938. In that year the first attempts were made to photograph the image on the kinescope tube.¹ The low light intensity of the image combined with the use of standard spring-wound cameras gave very unsatisfactory results. The most difficult problem was to synchronize the 30-frame/sec rate of the television screen with the 24-frame/sec rate that is standard motion picture practice. Twenty-four frames per second were necessary in order to use existing projection and sound apparatus. The most critical characteristic in the recording camera is the timing of the shutter blanking and exposure interval.² This problem has been solved by means

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of cameras incorporating specially designed mechanical or electronic shutters.

Essentially, a television film recorder consists of this special camera, a monitor which will give precise visual images and a sound recorder to pick up the accompanying sound. At present there are both 16-mm and 35-mm television film recorders with either single or double system sound.

Using 16-mm has the advantage of lower film and processing costs; it is approximately one third as expensive as 35-mm. No marked improvement is to be had by recording on 35-mm rather than 16-mm at the present time. With the use of fine-grain, high-resolution, 16-mm film emulsions, no loss of resolution in recording the television image is noticeable. Using 35-mm has the added disadvantage of very stringent fire regulations and, finally, the cost of 35-mm projection equipment is often prohibitive. As a result, most television stations are using 16-mm film for their recordings³; 35-mm film is being used primarily for theater television.

There are four main purposes for which television film recordings can be made at present:

1. *Transcriptions.* The transcription is the main function of television film recordings today. It is a recording of a

complete show either as it goes over the air or as a closed-circuit operation. It may be shown as: (a) *delayed telecast*, to make up for the difference in time zones between the east and west coasts; (b) *repeat telecast*, to catch a larger audience at a more appropriate time; or (c) *syndicated telecast*, in which case it is sent to a station that is not connected by either coaxial cable or microwave relay, and is shown at any convenient time.

2. *Theater television.* Television film recordings are used as an intermediate system of television projection. The program is picked up by receiving equipment at the theater. It is then recorded by 35-mm single system equipment. The signal is inverted and a direct-positive print results. The film is fed into rapid-processing machines where it is processed, dried and fed directly into the projection machine in a little over a minute from the time of exposure. This system allows theaters to show television programs using existing 35-mm projection equipment.⁴

3. *Research.* This includes recordings made for either auditions or previews. Recordings are often made to improve the quality of a program. Techniques of camera work, acting, lighting, set design and all the elements that go into a television show can be checked before the program is to go on the air.

4. *Reference.* There is no better way to keep a record of a television program than to record it as it goes over the air. It is possible that the F.C.C. may require a record kept of every program telecast.

Technically speaking, the quality of television film recording is fairly good and will continue to improve. With certain refinements, such as greater bandwidth and more lines, it should eventually be impossible to distinguish a television film recording from a film shot by a standard motion picture camera.

Dissatisfaction with present television film recording quality has led to the rise of the multicamera motion picture system. In this system a multiple camera setup utilizing three or more standard motion picture cameras is used. All cameras can operate simultaneously. By utilizing live television techniques of dollying and camera movement, the program is covered from a multitude of angles. With the use of an ingenious cuing system the films from the different cameras are later spliced together to form a complete television program.⁵ The use of multicamera setups is, of course, not new. They were extensively used some twenty years ago in the early days of sound.⁶ This system, at present, gives major-studio quality and as such deserves much merit. Assuming that eventually the quality of television film recording will equal that of standard motion picture practice, the multicamera system will not maintain its superiority over recording through the television camera which has these advantages:

1. The television camera has an enormous advantage over the standard motion picture camera, in that all it "sees" can be viewed instantly. All camera setups can be checked on the monitor for lighting and composition. There is no problem of parallax, focus or exposure. The director knows in advance exactly what the scene will look like. Many a director and cameraman in the major film industry would like to have this tremendous advantage. During the actual performance any mistakes can be seen and immediately reshot. There need be no waiting for "rushes" as there can be no doubt as to the scene's outcome.

2. It allows film to take advantage of the light amplification characteristics of the image orthicon camera. Thus it will be possible to film certain scenes under light conditions that are impossible with the standard motion picture camera.⁷ This means the use of

more natural lighting or the use of a minimum of lighting equipment.

3. Certain optical effects such as dissolves, fade-ins, fade-outs, double exposures and background shots can be made in the television cameras themselves. This adds to the economy of the system as it can reduce the cost of producing these special effects optically.

4. It allows the television station to utilize the equipment on hand. Thus the television camera can serve a dual purpose. It can be used for live television programs or it can be used in conjunction with the television film recorder. This allows the station complete control over program content as all programs can be made on the studio premises and conform to the station's needs.

5. Since all recording is accomplished at a central point, it should be easy to keep the recording and developing process under the strictest possible control. The potentialities of a system like this are unlimited and may make the standard motion picture camera as we know it today obsolete.

Filmically speaking, the present-day television film recording leaves much to be desired. It possesses the physical characteristics of motion picture film but lacks the inherent capabilities of the true motion picture, for it is restricted by the limitations of the live television program.

In a live television program a unity of time and space must be observed. Movement is confined by the physical limits of the stage itself. Performers must learn complete scripts. Changes in costume or makeup take time and there must be cover-up action during this period. Even when using two or more sets the performer can travel through them only at a certain speed. Transitions must either be eliminated or filmed in advance. Outdoor sets are seldom if ever used. During the performance any mistake is easily noticed and there is no chance to rectify it.

As a result of these restrictions, the average television play today resembles a stage play in that the story is advanced through the dialog. This is good stage technique, but is poor television. Television is a visual medium and as such the story could and should be advanced by visual means. Movement on the screen is interesting and tells its own story. Dialog is important but should never dominate the picture.

Editing

The true motion picture is not just a recording of reality but a rearrangement of that reality to suit its own purposes. Both the standard motion picture camera and the television film recorder are recording mechanisms. They can do nothing but record on film a scene that is placed before their lenses. Then how does the motion picture gain its flexibility and freedom of movement, its ability to manipulate time and space? The answer lies in the editing process. It is in the editing room that the motion picture, as we know it, comes into being.

Here is created filmic time and filmic space. Filmic time and filmic space exist only on the individual strips of motion picture film. Actual events can be stretched or compressed. Time can be made to stand still or to go forward or backward. It is possible to show events, occurring at widely separated points, and simultaneously. Unrelated shots are cut together and meaning is extracted from their juxtaposition. An accident occurs; we see, in rapid succession, the victim crossing the street, the driver's grim look, his foot slam on the brake, the victim's horrified face, the wheels skidding on the pavement, the victim lying in the street. A man steps out of a New York hotel into a South American street. These and many other scenes are possible only through the editing process. These are no mere tricks, they are the lifeblood of the visual medium. As a visual medium, television can use the editing principle

to its advantage. This will free television from the limitations imposed upon it by live television techniques.

At the present time, the major networks are editing television film recordings for the following reasons:

1. To make transitions which would otherwise be impossible if the program were recorded straight through.

2. To rerecord imperfect scenes.

3. To eliminate excess footage and edit the show down to required length.

In applying the editing principle to television film recording, it is well to note a major difference between the motion picture and television. Both, being visual mediums, have the shot as their foundation. However, the motion picture is filmed on a single-shot basis whereas television is set up on a multiple-shot basis. This is no handicap; quite the contrary, it can be used to great advantage.

In the motion picture each individual shot is arranged for maximum effect. There is always one certain camera angle that will be most effective depending upon what idea is being conveyed to the audience. Thus each scene is carefully arranged to put across this idea. Therefore, even the same scene when photographed from different angles will be rearranged to suit each individual shot even though all of these shots will be cut together to create a seemingly continuous scene.

This is not necessary in television, for the use of multiple cameras combined with electronic cutting makes it possible to get a variety of shots without making new setups for each individual shot. This can be done by careful planning of camera angles, the use of proper focal length lenses and the use of lighting to suit the scene. Here, of course, the maximum effect from each shot or cut is not as assured as in the single-shot setup, but such should be nearly attained. Thus it is possible to create a maximum number of shots with a minimum number of setups for any given scene. It is

proposed to use this type of multi-camera setup wherever the action will allow it.

In order to apply the editing principle to television film recording, pre-production planning is the first necessity. In addition to planning details of sets, costumes, props, etc., the script must be broken down into two types of sequences. The first type of sequence should consist of that kind of scene where two or more television cameras can be used for the necessary variety of shots. This type of scene will be recorded as a unit making full use of electronic cutting.

The second type of sequence should consist of that kind of scene where it is necessary to stop the recorder to make changes in lighting, costumes, sets, makeup, etc. This can be recorded with a multi-camera setup or, if circumstances demand, with only one camera.

In all instances, the various sequences will be recorded in whatever order is most practical. By minute scheduling of operations it should be possible to record the various sequences in the shortest amount of time. After processing, the recorded sequences can then be edited into a smooth, flexible program with a minimum of time and effort. The cost should approximate straight television film recording with the quality equaling that of professional motion picture practice.

This is a process in which we are utilizing the best features of motion pictures and television. We have given the television camera a memory. We have taken the unique picture-control elements of the television camera and added the permanency, flexibility and perfection of motion picture film. Thus the process is one that is peculiar to neither motion pictures nor television alone, but is a synthesis of the two that can be used to their mutual advantage.

It has been said that television will lose its sense of "immediacy" through

the use of television film recordings. It has also been said that the public likes to know that the program being telecast is being presented at that very moment. This all depends upon the type of program being considered. Every day millions of persons attend motion pictures that are from nine to twelve months old before being released. Even the earliest 'newsreels' are from a few days to several months old when being presented.

"Immediacy" is determined by program content. Obviously, no other medium is as well equipped to present an event as it actually happens as television. In reporting spot news, sport events, presidential elections and other events of great public interest, television can present these programs to the public as they actually occur. To this list can be added programs of a semirehearsed nature such as vaudeville, comedy or variety shows. However, rehearsed programs, especially drama of all varieties, need the perfection and flexibility that only a filmic use of the television film recorder can give them. There is no reason why drama should be presented live. The perfection and flexibility that can be had by this

method mean better dramatic programs and that is our ultimate goal.

This is where the future of television film recording lies and it doesn't interfere with any type of program in which "immediacy" is its most important aspect. To the contrary, it can record those programs of lasting interest and preserve them for posterity.

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ABSTRACT

The Genlock—A New Tool for Better TV Programming

By John H. Roe

RECENTLY, the need for more and better techniques in video programming has become more and more apparent, particularly as picture quality has improved, thus focusing attention on ideas for adding some of the finer touches. One of the gaps in the present programming structure arises from the lack of synchronization between two distinct program sources which may supply successive parts of a program. The field-frequency pulses may be phased together by manual adjustment and they will stay so as long as the same power source is the reference for both generators, but there is no such simple solution to the problem of phasing the line-frequency pulses.

Lack of tight lock-in between two such systems results in several programming limitations. For example, when the program line is switched from one system to the other, the receivers have to adjust themselves to the new synchronizing signal. The horizontal (line-frequency) scanning changes very quickly in most cases, but the vertical (field-frequency) scanning circuits have much more inertia and do not respond quickly. The usual result is, therefore,

that the picture on a receiver will "roll over," much to the annoyance of the viewer.

Another limitation is the impossibility of using lap-dissolves and superpositions involving pictures from two unrelated television pickup systems. The increasing use of lap-dissolves and superpositions in studio programs makes it seem more and more desirable to provide means to produce the same effects at all times regardless of the sources of the signals to be treated. To make them possible, the synchronizing signal generators must be locked together tightly, field for field and line for line, just as though the whole system were operating on one generator instead of two.

The most direct solution to this problem is to provide means for locking the local synchronizing signal generator, as a slave, to the remote generator, as a master. Once the equipment for this control of the local generator is functioning, the remote signals may be treated as local signals in any of the common types of switching transitions and superpositions, thus making it possible to go back and forth from one source to the other without concern as to the point of origination.

Foreseeing the need and the demand for simple, automatic and foolproof means for tying two television pickup systems together, RCA engineers have developed a device called the Genlock, which accomplishes the desired lock-in automatically without any manual phasing adjustment whatever.

Abstract by Pierre Mertz of a paper presented on September 26, 1950, at the National Electronics Conference at Chicago, Ill. (in which the SMPTE Central Section participated), by John H. Roe, Radio Corporation of America, RCA Victor Div., Camden, N.J. The complete paper will be published in *Proceedings of the National Electronics Conference*, vol. 6 (for 1950).

The Genlock

The Genlock is a unit which combines two separate circuits which serve to provide control signals to the line-frequency and field-frequency sections, respectively, of the local synchronizing signal generator.

The first consists of an automatic frequency-control discriminator which derives a varying d-c error signal from the comparison of the horizontal driving signal (from the local synchronizing signal generator) with the separated synchronizing signal derived from the remote picture signal. This latter synchronizing signal must be separated from the composite picture signal in some other equipment such as the RCA TA-5C stabilizing amplifier. No separator circuit is provided in the Genlock. The error signal is applied to the reactance tube in the local synchronizing signal generator, thus directly controlling the frequency and phase of the master oscillator. The control is rigid, allowing no perceptible horizontal drift or instability between the two pictures.

The second circuit compares the synchronizing signals, one from the local synchronizing signal generator and the other from the synchronizing signal separator operating on the remote picture signal, and from this comparison derives an error signal in the form of a positive pulse recurring at field frequency. As long as the two field-frequency signals are out of phase, the pulse exists, but as soon as they become coincident, the error pulse ceases to exist. The error signal is applied to the 7:1 counter circuit in the local synchronizing signal generator (RCA TG-1A or TG-10A) in such a way as to cause it to miscount. As long as the error signal continues to recur, the local field frequency drifts at an accelerated pace causing the two signals to approach in phase. At the instance of coincidence the error signal dis-

appears and the counter circuit begins to operate normally. Thereafter the two signals remain in phase as long as the Genlock continues to function.

The operation of the line-frequency control circuit is quite rapid so that lock-in of the horizontal scanning circuits appears to be almost instantaneous. The field-frequency control circuit, however, requires a variable amount of time to assume full control depending on the initial phase difference between the two signals. Phase shift brought about by the control occurs at a definite rate of three scanning lines per field. The maximum time required to achieve control is about 1.46 sec.

The Genlock never requires more than one field to bring the field-frequency pulses into phase. The reason is that when it causes the counter in the synchronizing signal generator to miscount, it is possible, under the proper conditions, to bring about a conversion of an "even" to an "odd" field, or vice versa.

The question may arise as to what happens if by some mischance the even field in one system is brought into coincidence with the odd field of the other system. The answer is that nothing serious takes place. The tops and bottoms of the two pictures are slightly displaced under such conditions.

From a practical point of view, it is not important to have exact coincidence of the top and bottom lines, respectively, in the two picture signals. Any lack of coincidence means simply that the edges of the two vertical blanking signals are slightly separated in time, and therefore, in space, on the picture tube. This results in a shift up or down, of the top and bottom of the raster at the time of switching by an amount proportional to the discrepancy. If the discrepancy is, for example, only one or two half-line intervals, the shift is almost impercep-

tible. In the average receiver it is hidden behind the mask and is not visible at all.

Thus it may be seen that the Genlock is entirely automatic in operation, and requires only the proper information in the form of suitable signals to bring about a solid "marriage" of the two synchronizing signal systems. The only control necessary is a switch for disconnecting the normal frequency reference standard and at the same time connecting the output of the Genlock to the proper circuits in the local synchronizing signal generator.

System Considerations

Two methods of using the Genlock in a television station are suggested. In the first case, where only one synchronizing signal generator is available at the studio, the connections between it and the Genlock are made through a switch. In the second case, where an additional or standby synchronizing signal generator is available at the studio, the Genlock is used to control the standby generator, and the system is transferred to Genlock operation by switching from one generator to the other. This is the preferable method because it permits previewing of Gen-

lock operation before the system is transferred.

In either case, because a transfer in or out of Genlock operation causes a transient disturbance in the operation of deflection circuits in receivers, it is desirable to make the transfer with the video output of the station faded down to black.

Inasmuch as the Genlock makes the local station dependent on a signal source which is remote and beyond the control of local operators, it is interesting to know what happens when the remote signal fails. The Genlock is so designed that, when the remote signal is lost, the local synchronizing signal generator continues to operate quite normally at a rate which is very close to that existing under Genlock control. In other words, the synchronizing signal generator becomes free-running, depending only on the stability of its master oscillator. When the remote signal is restored, the Genlock regains control in the same way as when initially put into operation.

Acknowledgment: Credit is due to F. W. Millspaugh and A. H. Turner, who contributed much to the development of this device, and to Dr. H. N. Kozanowski, under whose direction the work was done.

Standards

Standards Symbol Changed to PH

IT HAS BEEN ASA's practice to designate each related group of its various activities with a single letter symbol. The letter "Z" was reserved for those "miscellaneous" committees not considered large enough to warrant assignment of a separate symbol. The 30-year old Section Committee on Photography, Z38, has been in that category along with Sectional Committee on Motion Pictures Z22.

Phenomenal growth of interest in photographic standards in recent years has so expanded Z38 that it became too large to function efficiently under its old organization, so ASA and the committee members agreed to certain essential changes. Z38 was divided into four separate committees, which together with Z22 were then placed under the administration of a newly established Photographic Standards (Correlating)

Committee. A new letter designation was established to cover the entire group. In view of the imminent need for a double-letter code system, the letter P, first proposed because it had not been used before, was expanded to PH and is now the common symbol for all sectional committees on photography. ASA has officially assigned the following designations to the following committees:

- PH1 Films, Plates and Papers
- PH2 Photographic Sensitometry
- PH3 Photographic Apparatus
- PH4 Photographic Processing
- PH22 Motion Pictures

These changes in no way affect the scope or membership of the Sectional Committee on Motion Pictures, but change only the code numbers on all new standards. The first proposed standards to carry the new numbers follow in this issue.

Cutting and Perforating 32-Mm Film

TWO APPROVED American standards for cutting and perforating 32-mm film appear on the following pages. These standards were first published in the February, 1949, JOURNAL as proposals to elicit comments or criticisms. Since no adverse criticism was received, they were processed through the required channels and officially approved on October 6, 1950.

Although film of this type has been used commercially since 1934, there never has been a formal standard. During the intervening years a number of

changes have been made in the dimensions. Debie, who was the originator of the slit-film process for release printing, was aware that slitting of 32-mm film into two 16-mm widths might be inaccurate. This inaccuracy would make one half wider than the other half, and could cause trouble in the projector gate. Therefore, he made the original French film narrower than twice the width of 16-mm film. The first French film was about 1.252 in. in width. Manufacturers in this country made film of this width for some time but later

widened it by 0.005 in. to make it 1.257 in.

It appears that there have been four or five slightly different styles of perforating in use at various times. Values currently adopted for film width and for transverse pitch of the perforations are believed to be acceptable to all manufacturers. Differences between the

present standards and the earlier dimensions are so slight, it is doubtful that the users can perceive them. Dimensions of the perforation, longitudinal pitch, and the like, are the same as those of current 16-mm film. Dimensioning of the drawings is consistent with the standards for 16-mm raw stock (Z22.5-1947 and Z22.12-1947).

16-Mm Projection Reels

PUBLICATION in the February, 1950, JOURNAL of a proposed complete revision of the American Standard for 16-Mm Projection Reels, Z22.11-1941, resulted in a number of comments. Consideration of these comments by the 16-Mm and 8-Mm Motion Pictures Committee, which developed this proposal, has led to recommendation of changes in dimensions R, S, and T, and in Note 7 (formerly Note 3). Although

not apparent on the surface, the intent of these changes is to make possible the design of plastic reels within the standard dimensions. Because of the nature of these changes, the Standards Committee agreed that the revised proposal, as it appears on the following pages, should be republished for ninety days trial and criticism. Please send comments to Henry Kogel, Staff Engineer at Society Headquarters, before June 1, 1951.

Projection Lamps

PROPOSED STANDARDS for two types of projection lamps, developed by the 16-Mm and 8-Mm Motion Pictures Committee, appear on the following pages. They are published here for trial and criticism for a period of ninety days. Please forward any comments to Henry Kogel, Staff Engineer at Society headquarters, by June 1, 1951.

The first of these two proposals, PH 22.84, is entitled Dimensions for Projection Lamps, Medium Prefocus Ring Double-Contact Base-Up Type for 16-Mm and 8-Mm Motion Picture Projectors. It shows a type of base developed recently to provide improved filament positioning, better cooling, and easier replacement with the objective of making the lamp compatible with other recently refined projector elements. In a way, this design has been an ideal subject for standardization in that it is not

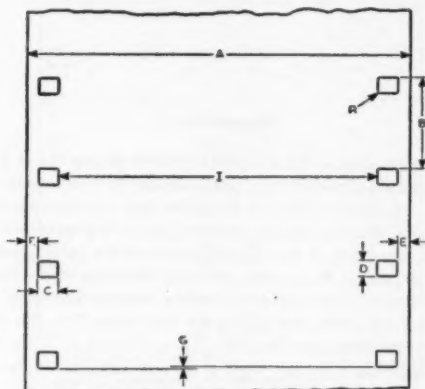
yet in widespread use and consequently, once the general scheme was agreed upon, the Committee did not have to compromise because of existing practices. The base covered by the proposal is the subject of a patent assigned to the General Electric Company. However, after a search by the Society disclosed no other active patents on pertinent bases, rings or sockets, the General Electric Company agreed to dedicate this patent to the public, clearing the way for standardization.

The second proposed standard is for Dimensions for Projection Lamps, Medium Prefocus Base-Down Type for 16-Mm and 8-Mm Motion Picture Projectors, PH22.85. It will be recognized that lamps of this design have been in general use for many years; however, there has been no American Standard for the dimensions.

American Standard
Cutting and Perforating Dimensions for
32-Millimeter Sound Motion Picture
Negative and Positive Raw Stock

ASA
Reg. U. S. Pat. Off.
PH22.71 - 1950
(Z22.71 - 1950)
*UDC 778.534.4

Page 1 of 2 Pages



Dimensions	Inches	Millimeters
A	1.257 ± 0.001	31.93 ± 0.025
B*	0.300 ± 0.0005	7.620 ± 0.013
C	0.0720 ± 0.0004	1.83 ± 0.01
D	0.0500 ± 0.0004	1.27 ± 0.01
E	0.036 ± 0.002	0.91 ± 0.05
G	Not > 0.001	Not > 0.025
I	1.041 ± 0.002	26.44 ± 0.05
L**	30.00 ± 0.03	762.00 ± 0.76
R	0.010 ± 0.001	0.25 ± 0.025

These dimensions and tolerances apply to the material immediately after cutting and perforating.

* In any group of four consecutive perforations, the maximum difference of pitch shall not exceed 0.001 inch and should be as much smaller as possible.

** This dimension represents the length of any 100 consecutive perforation intervals.

Approved October 6, 1950, by the American Standards Association, Incorporated

Sponsor: Society of Motion Picture and Television Engineers

*Universal Decimal Classification

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American Standard
**Cutting and Perforating Dimensions for
32-Millimeter Sound Motion Picture
Negative and Positive Raw Stock**

ASA
Reg. U. S. Pat. Off.
PH22.71 — 1950
(Z22.71 — 1950)

Page 2 of 2 Pages

Appendix

The dimensions given in this standard represent the practice of film manufacturers in that the dimensions and tolerances are for film immediately after perforation. The punches and dies themselves are made to tolerances considerably smaller than those given, but owing to the fact that film is a plastic material, the dimensions of the slit and perforated film never agree exactly with the dimensions of the punches and dies. Shrinkage of the film, due to change in moisture content or loss of residual solvents, invariably results in a change in these dimensions during the life of the film. This change is generally uniform throughout the roll.

The uniformity of perforation is one of the most important of the variables affecting steadiness of projection.

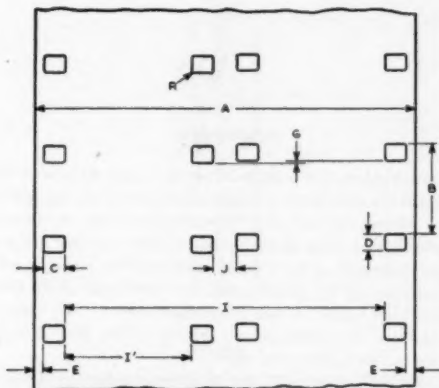
Variations in pitch from roll to roll are of little significance compared to variations from one sprocket hole to the next. Actually, it is the maximum variation from one sprocket hole to the next within any small group that is important. This is one of the reasons for the method of specifying uniformity in dimension B.

Thirty-two-millimeter release print stock is slit, after printing and developing, to 16-mm width. Since a possible error is involved in this slitting, the width of 32-mm film is made 0.001 inch narrower than twice the width of standard 16-mm film. This narrowing gives a tolerance of 0.001 inch in this secondary slitting operation. If the error of slitting exceeds this tolerance, one of the 16-mm halves may exceed the width allowed for 16-mm film and cause interference in the gate of a projector. In addition to errors of centering, there are errors caused by recurring variations in width. These errors will cause weave on the screen even though the maximum width of the film may not be great enough to cause interference in the projector gate.

American Standard
Cutting and Perforating Dimensions for
32-Millimeter Silent Motion Picture
Negative and Positive Raw Stock

ASA
Rev. U. S. Pat. Off.
PH22.72 - 1950
(Z22.72 - 1950)
*UDC 778.5

Page 1 of 2 Pages



Dimensions	Inches	Millimeters
A	1.257 ± 0.001	31.93 ± 0.025
B*	0.300 ± 0.0005	7.620 ± 0.013
C	0.0720 ± 0.0004	1.83 ± 0.01
D	0.0500 ± 0.0004	1.27 ± 0.01
E	0.036 ± 0.002	0.91 ± 0.05
G	Not > 0.001	Not > 0.025
I	1.041 ± 0.002	26.44 ± 0.05
I'	0.413 ± 0.001	10.490 ± 0.025
J	0.071 ± 0.001	1.803 ± 0.025
L**	30.00 ± 0.03	762.00 ± 0.76
R	0.010 ± 0.001	0.25 ± 0.025

These dimensions and tolerances apply to the material immediately after cutting and perforating.

* In any group of four consecutive perforations, the maximum difference of pitch shall not exceed 0.001 inch and should be as much smaller as possible.


** This dimension represents the length of any 100 consecutive perforation intervals.

Approved October 6, 1950, by the American Standards Association, Incorporated
Sponsor: Society of Motion Picture and Television Engineers

*Universal Decimal Classification

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American Standard
**Cutting and Perforating Dimensions for
32-Millimeter Silent Motion Picture
Negative and Positive Raw Stock**


Reg. U. S. Pat. Off.
PH22.72 - 1950
(Z22.72 - 1950)

Page 2 of 2 Pages

Appendix

The dimensions given in this standard represent the practice of film manufacturers in that the dimensions and tolerances are for film immediately after perforation. The punches and dies themselves are made to tolerances considerably smaller than those given, but owing to the fact that film is a plastic material, the dimensions of the slit and perforated film never agree exactly with the dimensions of the punches and dies. Shrinkage of the film, due to change in moisture content or loss of residual solvents, invariably results in a change in these dimensions during the life of the film. This change is generally uniform throughout the roll.

The uniformity of perforation is one of the most important of the variables affecting steadiness of projection.

Variations in pitch from roll to roll are of little significance compared to variations from one sprocket hole to the next. Actually, it is the maximum variation from one sprocket hole to the next within any small group that is important. This is one of the reasons for the method of specifying uniformity in dimension B.

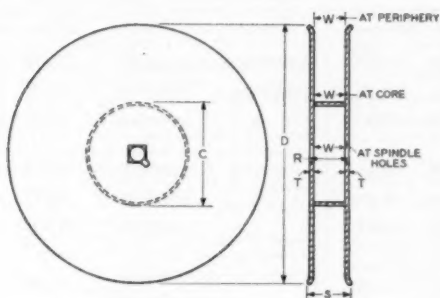
Thirty-two-millimeter release print stock is slit, after printing and developing, to 16-mm width. Since a possible error is involved in this slitting, the width of 32-mm film is made 0.001 inch narrower than twice the width of standard 16-mm film. This narrowing gives a tolerance of 0.001 inch in this secondary slitting operation. If the error of slitting exceeds this tolerance, one of the 16-mm halves may exceed the width allowed for 16-mm film and cause interference in the gate of a projector. In addition to errors of centering, there are errors caused by recurring variations in width. These errors will cause weave on the screen even though the maximum width of the film may not be great enough to cause interference in the projector gate.

Proposed American Standard
16-Millimeter Motion Picture
Projection Reels

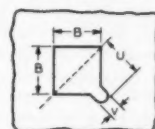
(Second Draft)

PH22.11
(Z22.11)

P. 1 of 3 pp.



ENLARGED VIEW OF HOLE IN
FLANGE ON LEFT IN SECTIONAL
VIEW SHOWN ABOVE



ENLARGED VIEW OF HOLE IN
FLANGE ON RIGHT IN SECTIONAL
VIEW SHOWN ABOVE

TABLE 1

Dimension	Inches	Millimeters
A	0.319 $\begin{smallmatrix} +0.000 \\ -0.003 \end{smallmatrix}$	8.10 $\begin{smallmatrix} +0.00 \\ -0.08 \end{smallmatrix}$
B	0.319 $\begin{smallmatrix} +0.000 \\ -0.003 \end{smallmatrix}$	8.10 $\begin{smallmatrix} +0.00 \\ -0.08 \end{smallmatrix}$
R ¹	0.790 maximum	20.06 maximum
S ² (including flared, rolled, or beveled edges)	0.962 maximum	24.43 maximum
T (adjacent to spindle)	0.027 minimum 0.066 maximum	0.69 minimum 1.68 maximum
U	0.312 ± 0.016	7.92 ± 0.41
V	0.125 $\begin{smallmatrix} +0.005 \\ -0.000 \end{smallmatrix}$	3.18 $\begin{smallmatrix} +0.13 \\ -0.00 \end{smallmatrix}$
W, at periphery ³	0.660 $\begin{smallmatrix} +0.045 \\ -0.025 \end{smallmatrix}$	16.76 $\begin{smallmatrix} +1.14 \\ -0.64 \end{smallmatrix}$
at core ⁴	0.660 ± 0.010	16.76 ± 0.25
at spindle holes	0.660 ± 0.015	16.76 ± 0.38
Flange and core concentricity ⁵	± 0.031	± 0.79

See Notes on p. 3.

NOT APPROVED

Proposed American Standard
16-Millimeter Motion Picture
Projection Reels

(Second Draft)

PH22.11
(Z22.11)

P. 2 of 3 pp.

TABLE 2

Capacity	Dimension	Inches	Millimeters	Capacity	Dimension	Inches	Millimeters
200 Feet ⁶ (61 Meters)	D, nominal	5.000	127.00	1200 Feet (366 Meters)	D, nominal	12.250	311.15
	maximum	5.031	127.79		maximum	12.250	311.15
	minimum	5.000	127.00		minimum	12.125*	307.98*
	C, nominal	1.750	44.45		C, nominal	4.875	123.83
	maximum	2.000*	50.80*		maximum	4.875	123.83
	minimum	1.750	44.45		minimum	4.625*	117.48*
	Lateral run-out, ⁷ maximum	0.570	1.45		Lateral run-out, ⁷ maximum	0.140	3.56
400 Feet ⁶ (122 Meters)	D, nominal	7.000	177.80	1600 Feet (488 Meters)	D, nominal	13.750	349.25
	maximum	7.031	178.59		maximum	14.000*	355.60*
	minimum	7.000	177.80		minimum	13.750	349.25
	C, nominal	2.500	63.50		C, nominal	4.875	123.83
	maximum	2.500	63.50		maximum	4.875	123.83
	minimum	1.750*	44.45*		minimum	4.625*	117.48*
	Lateral run-out, ⁷ maximum	0.080	2.03		Lateral run-out, ⁷ maximum	0.160	4.06
800 Feet (244 Meters)	D, nominal	10.500	266.70	2000 Feet (610 Meters)	D, nominal	15.000	381.00
	maximum	10.531	267.49		maximum	15.031	381.79
	minimum	10.500	266.70		minimum	15.000	381.00
	C, nominal	4.875	123.83		C, nominal	4.625	117.48
	maximum	4.875	123.83		maximum	4.875	123.83
	minimum	4.500*	114.30*		minimum	4.625	117.48
	Lateral run-out, ⁷ maximum	0.120	3.05		Lateral run-out, ⁷ maximum	0.171	4.34

NOT APPROVED

Proposed American Standard
16-Millimeter Motion Picture
Projection Reels

(Second Draft)

PH22.11
(Z22.11)

NOTES

* When new reels are designed, or when new tools are made for present reels, the cores and flanges should be made to conform, as closely as practicable, to the nominal values in the above table. It is hoped that in some future revision of this standard the asterisked values may be omitted.

¹ The outer surfaces of the flanges shall be flat out to a diameter of at least 1.250 inches.

² Rivets or other fastening members shall not extend beyond the outside surfaces of the flanges more than 1/32 inch (0.79 millimeters) and shall not extend beyond the over-all thickness indicated by dimension S.

³ Except at embossings, rolled edges, and rounded corners, the limits shown here shall not be exceeded at the periphery of the flanges, nor at any other distance from the center of the reel.

⁴ If spring fingers are used to engage the edges of the film, dimension W shall be measured between the fingers when they are pressed outward to the limit of their operating range.

⁵ This concentricity is with respect to the center line of the hole for the spindles.

⁶ This reel should not be used as a take-up reel on a sound projector unless there is special provision to keep the take-up tension within the desirable range of 1 1/4 to 5 ounces.

⁷ Lateral runout is the maximum excursion of any point on the flange from the intended plane of rotation of that point when the reel is rotated on an accurate, tightly fitted shaft.

APPENDIX

Dimensions A and B were chosen to give sufficient clearance between the reels and the largest spindles normally used on 16-millimeter projectors. While some users prefer a square hole in both flanges for laboratory work, it is recommended that such reels be obtained on special order. If both flanges have square holes, and if the respective sides of the squares are parallel, the reel will not be suitable for use on some spindles. This is true if the spindle has a shoulder against which the outer flange is stopped for lateral positioning of the reel. But the objection does not apply if the two squares are oriented so that their respective sides are at an angle.

For regular projection, however, a reel with a round hole in one flange is generally preferred. With it the projectionist can tell at a glance whether or not the film needs rewind-

ing. Furthermore, this type of reel helps the projectionist place the film correctly on the projector and thread it so that the picture is properly oriented with respect to rights and lefts.

The nominal value for W was chosen to provide proper lateral clearance for the film, which has a maximum width of 0.630 inch. Yet the channel is narrow enough so that the film cannot wander laterally too much as it is coiled; if the channel is too wide, it is likely to cause loose winding and excessively large rolls. The tolerances for W vary. At the core they are least because it is possible to control the distance fairly easily in that zone. At the holes for the spindles they are somewhat larger to allow for slight buckling of the flanges between the core and the holes. At the periphery the tolerances are still greater because it is difficult to maintain the distance with such accuracy.

Minimum and maximum values for T, the thickness of the flanges, were chosen to permit the use of various materials.

The opening in the corner of the square hole, to which dimensions U and V apply, is provided for the spindles of 35-millimeter rewinds, which are used in some laboratories.

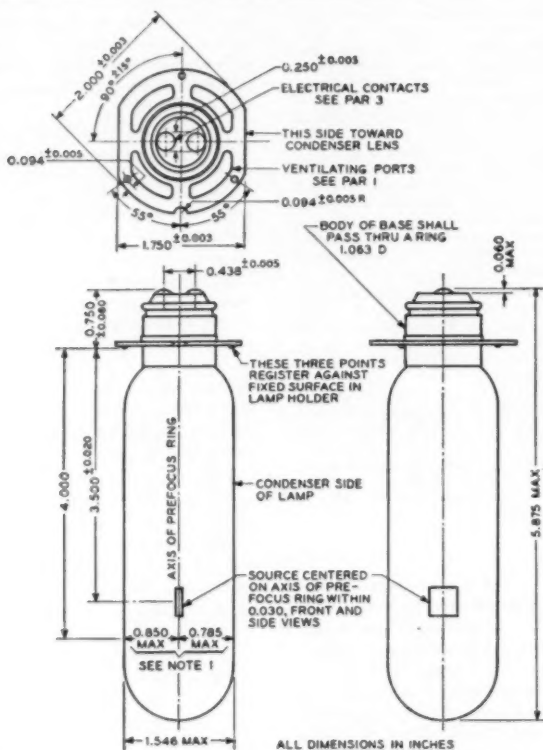
D, the outside diameter of the flanges, was made as large as permitted by past practice in the design of projectors, containers for the reels, rewinds, and similar equipment. This was done so that the values of C could be made as great as possible. Then there is less variation, throughout the projection of a roll, in the tension to which the film is subjected by the take-up mechanism, especially if a constant-torque device is used. Thus it is necessary to keep the ratio of flange diameter to core diameter as small as possible, and also to eliminate as many small cores as possible. For the cores, rather widely separated limits (not intended to be manufacturing tolerances) are given in order to permit the use of current reels that are known to give satisfactory results.

NOT APPROVED

Proposed American Standard
 Dimensions for Projection Lamps
 Medium Prefocus Ring Double-Contact Base-Up Type
 for 16-Mm and 8-Mm Motion Picture Projectors

PH22.84

P. 1 of 2 pp.



1. Scope. The purpose of this standard is to establish, for the type of lamp shown, the dimensions essential to interchangeability of lamps in projectors. It is not intended to prescribe either operating characteristics or details of design such as the shape of the ven-

tilation ports or method of attachment of the prefocus ring to the base.

2. Operating Position. Lamps of this type are intended to be burned with the axis in an essentially vertical position, and with the base at the top.

NOT APPROVED

Proposed American Standard
Dimensions for Projection Lamps
Medium Prefocus Ring Double-Contact Base-Up Type
for 16-Mm and 8-Mm Motion Picture Projectors

PH22.84

P. 2 of 2 pp.

3. Electrical Contacts. The drawing indicates the area which the electrical members of the lamp holder should contact. It is not intended to dictate the shape of the terminals on the lamp. With lamps of this type, the prefocus ring is not an electrical contact.

Note 1. These dimensions define the maximum excursion of the bulb surfaces from the base axis toward

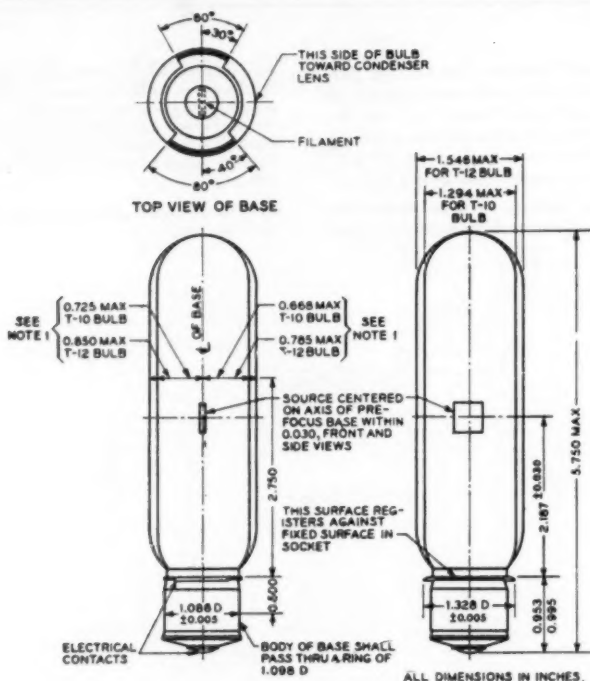
the condensing lenses and the mirror at the points indicated when the lamp is inserted in a holder which rotationally positions the lamp as shown in the end view of the base. Condensing lenses, the mirror, and their mounts must therefore be so located as to insure adequate clearance between these parts and the bulb surface.

Note 2. For medium prefocus base-down projection lamps, see PH22.85.

NOT APPROVED

Proposed American Standard
 Dimensions for Projection Lamps
 Medium Prefocus Base-Down Type
 for 16-Mm and 8-Mm Motion Picture Projectors

PH22.85



1. Scope. The purpose of this standard is to establish, for the type of lamp shown, the dimensions essential to interchangeability of lamps in projectors. It is not intended to prescribe either operating characteristics or details of design.

2. Operating Position. Lamps of this type are intended to be burned with the axis in an essentially vertical position, and with the base at the bottom.

Note 1. These dimensions define the maximum excursion of the bulb surfaces from the base axis toward the condensing lenses and the mirror at the points indicated when the lamp is inserted in a holder which rotationally positions the lamp as shown in the end view of the base. Condensing lenses, the mirror, and their mounts must therefore be so located as to insure adequate clearance between these parts and the bulb surface.

Note 2. For medium prefocus ring double-contact base-up projection lamps, see PH22.84.

NOT APPROVED

69th Semiannual Convention

PAPERS for presentation at the Spring Convention at the Statler Hotel in New York, April 30-May 4, are now being assembled by the 1951 Papers Committee. Committee appointments were completed in early February. The six Vice-Chairmen and all committee members are listed below. Members who wish to make a presentation at this convention or who know of developments which should be reported on promptly are requested to correspond directly with the proper Papers Committee Vice-Chairman. Each of these Vice-Chairmen has available copies

of the present Author's Forms, "Hints to Authors" (which suggests appropriate ways of manuscript preparation) and copies of American Standard Z38.7.19-1950 Dimensions of Lantern Slides. Be sure to contact your Papers Committee member promptly, for an early publication date for the Tentative Program has been established. It is essential that these deadlines be maintained so that members whose attendance at the convention depends upon the presentation of technical material in their own fields may be able to make their plans.

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M. G. Townsley, Bell & Howell, 7100 McCormick Rd., Chicago 45, Ill.

Board of Governors Meeting

PROGRESS was the keynote of the Annual Meeting of the Society's Board of Governors held in New York on January 24. The Chairman was Peter Mole, Society President, who took office the first of this year.

The Board first reviewed the Society's business, technical and publications activities for the year 1950, hearing reports by several officers. Since Ralph B. Austrian, Financial Vice-President was unable to attend the meeting, Frank E. Cahill, Treasurer, presented the report of business activities and a summary of the financial status of the Society as of December 31, 1950. His analysis of operations showed that 1950 was the Society's busiest year but that although the Society's income was up, administrative expenses were down, being actually slightly lower than the previous year.

ENGINEERING

Technical activities were reported by Fred T. Bowditch, Engineering Vice-President. Among the items which he reviewed was the much discussed question of whether the Society should or should not formally request that the American Stand-

ards Association send out a call for a meeting of technical committee TC-36, Cinematography, of the International Standardization Organization (ISO). Such a meeting had been proposed for this coming summer in Switzerland and it was felt that the Society's position of responsibility in this connection made a prompt decision mandatory. After soliciting the opinions of several Society members who had been seriously interested in standards on an international basis for many years, the Board of Governors concluded that calling such a meeting at this time would be quite inefficient and would represent considerable waste of time and money because no specific agenda had been developed. The Board did recommend, however, that vigorous attention be given to the international standards picture by the ASA Sectional Committee on Motion Pictures and by our own standards and technical committees. A responsible agenda could doubtless be developed in time for the ISO meetings already scheduled for 1952 in the United States.

The Board voted sponsor approval of three proposed American Standards which subsequently require the approval of

ASA's Photographic Standards (Correlating) Committee and also of the ASA Board of Review. They cover Dimensions for 32/35-mm Negative Stock; Focus Base Point for 16- and 8-mm Cameras; and Threads and Flange Distances for 16- and 8-mm Camera Lenses.

PUBLISHING

Since neither Clyde R. Keith, former Editorial Vice-President, nor John G. Frayne, Editorial Vice-President for 1951-52, was able to attend the meeting, their written reports were offered by the Secretary. Mr. Frayne announced reappointment of Arthur C. Downes as Chairman of the Board of Editors, and observed that the Society was particularly fortunate in having had such a capable engineer take a great personal interest in the Society's JOURNAL. He announced also that Edward S. Seeley had been appointed National Chairman of the Papers Committee and that he would be assisted during 1951 by five regional Vice-Chairmen and one Vice-Chairman representing a specialized industry group (see Convention story above).

Charles W. Handley had been reappointed Chairman of the Progress Committee and Edmund A. Bertram had accepted the Chairmanship of the Historical and Museum Committee. Mr. Keith observed that the budget limitations during the last three months of 1950 had forced a slight reduction in the amount of material published in the JOURNAL. Changes which he, Mr. Frayne and Victor Allen had agreed on for JOURNAL format would improve appearance of the JOURNAL and it was noted that some budget relief might be achieved. Two other changes were the addition of abstracts of technical articles published elsewhere but not generally available to members, and the preparation of semitechnical reports of local Section meetings which were of serious interest to Society members but for which no formal manuscript had been prepared by the speaker. It was suggested that members in the three local Sections might be persuaded to prepare such reports regularly.

RECORDING DISCUSSIONS

Over the years, many attempts were made to record the discussions which fol-

low presentation of technical papers at Society Conventions. Stenotype operators had been employed, as well as recording methods which used embossed tape, discs and quarter-inch magnetic tape. During the convention in Lake Placid last year, a professional model of magnetic recording machine was loaned to the Society and proved to yield the best results achieved so far. Mr. Keith suggested that a similar method, somewhat simplified, might well be adopted as a permanent system for recording, since the yield was higher and the cost somewhat lower than when using a stenotype operator. The Board accepted this suggestion and authorized Mr. Keith to proceed with the design and acquisition of suitable equipment which would be owned by the Society and maintained by the Headquarters Staff.

Another project that had been under Mr. Keith's supervision was the design of a more symbolic emblem for the Society to replace the one currently used on Society letterhead. Mr. Keith resigned as Chairman of that committee and Mr. Mole was asked to discuss the further activity along those lines with Lorin D. Grignon.

CONVENTIONS

In reviewing the 67th and 68th Conventions held in Chicago and Lake Placid during 1950, Mr. Kunzmann reported with some enthusiasm that income from registrations had offset convention expenses and he was able to turn in a black figure at the end of the year. He also reported on arrangements for the 69th Convention, in New York, as well as the 70th Convention, scheduled for the Hollywood-Roosevelt Hotel, October 15-19, 1951.

PLANNING FOR 1951

With reports of Society activity for 1950 completed, the Board considered the proposed budget for 1951 and endorsed a program of expansion, which included current growth in every phase of the Society's work. Space limitations at Society Headquarters have hampered engineering and publications activities to an extent that began to assume serious proportions. In recognizing this problem, the Board authorized the Executive Secretary to acquire larger quarters and to employ two additional staff members. One will pro-

vide additional stenographic assistance and the other will be a young engineer, assigned almost entirely to the Society's Test Film Program. His interests would be along the lines of quality control, test film production and the more accurate specification of particular films, either now being made or proposed for the future.

Expansion of publications activity by 72% was authorized and it was pointed out that the change in JOURNAL format would allow the editor to purchase the same amount of printed information for each dollar during 1951 as he did during the early months of 1950, even though general publications costs had increased considerably. Demand for additional technical work by Headquarters and by many of the committees seemed completely

justified and an increase of the services thus provided by as much as 100% was authorized.

Membership procedures have been simplified so that a fairly large increase in the rolls could be handled by Headquarters with very little additional effort. This increased efficiency makes it practical for the Society to invite membership from many potential applicants who have not been aware of the services available. Headquarters has been requested to apply additional effort along these lines, with the hope that every potential candidate for membership will learn of the Society and its JOURNAL and as a consequence will be able to judge whether the benefits warrant his joining.

1951 Nominations

'VOTING' members of the Society, that is all those in the Active, Fellow and Honorary grades, are invited by the Chairman of the Nominating Committee to suggest candidates for the seven Board of Governors' vacancies which will occur at the end of 1951. Since the Nominating Committee for this year will soon begin its formal deliberations, names of potential nominees should be placed in the hands of the Chairman, Earl I. Sponable, c/o Movietone Inc., 460 W. 54 St., New York 19, without delay.

Vacancies will be for the offices held now by the following members of the Board of Governors. The only limitations on suggested candidates for these vacancies are that they be *Voting* members of the Society.

Financial Vice-President, Ralph B. Austrian

Treasurer, Frank E. Cahill, Jr.

Governors, Lorin D. Grignon, Paul J. Larsen, William H. Rivers, Edward S. Seeley and R. T. Van Niman

Engineering Activities

Magnetic Recording

In the September, 1950, JOURNAL, it was reported that the proposals for Magnetic Sound Track on Film, originating in Glenn Dimmick's Subcommittee, were meeting obstacles in the parent Sound Committee. Those obstacles have been overcome and the proposals are now before the members of the Standards Committee, who are now balloting on their recommendation for preliminary publication for trial and comment.

Laboratory Practices

The Laboratory Practice Committee, under the Chairmanship of John Stott, met in January and pushed ahead on its ambitious program.

The work on 35-mm negative notching is reaching a conclusion and the committee will soon be canvassed on approval of the draft specification for size and location of notches.

16-Mm negative notching has presented a more thorny problem which will require

industry-wide assistance for solution. To this end, an interim committee report is being prepared for publication, with the expectation that sufficient comments will thus be elicited to enable the writing of an adequate draft specification.

A report of the Screen Brightness Survey of the 16-mm review rooms of the film processing laboratories was submitted. On the basis of the data accumulated at both East and West Coast laboratories, it

was recommended that a 16-mm screen brightness standard be drafted, and concrete proposals to that effect are in the making.

The committee has been planning for some time to provide abstracts of chemical engineering material for a regular page in the JOURNAL. Proposals to achieve this were discussed and responsibilities fixed. We can, therefore, expect this valuable service to be initiated shortly.

Obituaries

Joseph Mina Bing, who was an influential force in amateur photography and in the photographic industry, died at his home in New York on December 9, 1950. He was 72 years old. He was born in Vienna and was graduated from the University of Vienna with the degree of Doctor of Engineering. He was engaged in consulting railroad work in Austria, South and Central American Countries and in the building of the Hell Gate Bridge.

In 1925 he became the first importer of photographic exposure meters, in which field he was an expert and designer. He later became one of the largest importers of cameras and other equipment. During World War II his manufacturing organization received two Army-Navy awards for its excellent work in producing Navy testing equipment and design of the underwater camera. Mr. Bing was an Honorary Fellow of both the Royal Photographic Society and the Photographic Society of America. He had been an Active Member of this Society for 22 years.

Lewis M. Townsend died on October 16, 1950. He had long been an active member in the Society. In 1925 he coauthored with L. A. Jones a paper "The Use of Color for the Embellishment of the Motion Picture Program," which was published in the TRANSACTIONS of the Society. He was also coauthor of many other papers. For several years he was Chief Projection Engineer of the Eastman Theatre and the School of Music at the University of Rochester. He was Technical Adviser on Sound Equipment for Paramount Publix from 1929 to 1932 and from 1932 until his

death he was Chief Projectionist and Head of Equipment Maintenance for Schine Theaters, Inc.

Jack E. Beach was killed in a plane that crashed on Mt. Moran, Wyoming, November 21. He was 23 years old. He had worked as an assistant cameraman for Coronet Studios and as cameraman for C. O. Baptista Films, before being appointed to the staff of the New Tribes Mission as Production Manager in charge of their film work, which was to have been an exposition of missionary activities in the South. It was a mission-owned plane, destined for Florida, Bolivia and Brazil, on which he was killed.

Joseph W. Fleming, Manager of the Technical Information Center for Philips Laboratories, Irvington-on-Hudson, N.Y., was killed in an automobile accident on February 12, near his home in Edgewater, N.J. He had been an IATSE Member and had his own radio and sound business from 1929 to 1942 when he became associated with National Broadcasting Co. as Sound and Maintenance Engineer. Well known in radio and television, Mr. Fleming had served overseas in World War II as technical adviser to the U.S. Air Force in Europe and the Royal Air Force. At that time, he was also attached to the British Ministry of Aircraft Production. He had been an Active Member of this Society since 1947. He was also a member of the Audio Engineering Society, Institute of Radio Engineers and Photographic Society of America.

New Members

The following members have been added to the Society's rolls since those published last month. The designations of grades are the same as those used in the 1950 MEMBERSHIP DIRECTORY.

Honorary (H) Fellow (F) Active (M) Associate (A) Student (S)

- Babb, Harry L.**, Salesman, Eastman Kodak Co. **Mail:** 710 Crenshaw Blvd., Los Angeles 5, Calif. (A)
- Barton, Cecil W.**, Electrical Technician, Universal Pictures Corp. **Mail:** 13924 Weddington St., Van Nuys, Calif. (M)
- Bernd, Lester E.**, 16-Mm Motion Picture Producer, Delaware Steeplechase & Race Association. **Mail:** 11 Comeau St., Wellesley Hills 82, Mass. (M)
- Bieling, Robert O.**, Head, Film Quality Control, Bell & Howell Co. **Mail:** 96 Commonwealth Rd., Rochester 18, N.Y. (M)
- Blaskiewicz, John V.**, New Institute for Film and Television. **Mail:** 625 Hinsdale St., Brooklyn 7, N.Y. (S)
- Braaten, Norman J.**, Audio-Visual Electronics Technician, Minneapolis Board of Education. **Mail:** 5152 29 Ave., S., Minneapolis 17, Minn. (A)
- Brueckner, Hubert U.**, Superintendent, Optical Shop, Revere Camera Co. **Mail:** 1117 S. East Ave., Oak Park, Ill. (M)
- Cambi, Enzo**, Consulting Engineer, Cinecittà Studios; Lecturer, National Research Council (Italy) and Leghorn Naval Academy. **Mail:** Via Giovanni Antonelli 3, Rome, Italy. (A)
- Cheda, Paul M.**, Artist. **Mail:** 90-47 53 Ave., Elmhurst, L.I., N.Y. (A)
- Chen, Aegem**, University of Southern California. **Mail:** 2610½ N. Broadway, Los Angeles 31, Calif. (S)
- Cole, Henry James**, Photographer, National Institutes of Health, U.S. Public Health Service. **Mail:** 212 Piping Rock Dr., R.F.D. #2, Silver Spring, Md. (M)
- Day, James A.**, Projection Supervisor, WXYZ-TV, Inc. **Mail:** 12768 Elgin Ave., Huntington Woods, Mich. (A)
- Duncan, Cyril J.**, Director, Dept. of Photography, University of Durham, King's College, Newcastle Upon Tyne, 1, England. (M)
- Franzen, Russell G.**, Industrial Photographer, American Can Co. **Mail:** 1412 S. Fourth Ave., Maywood, Ill. (M)
- Fussel, Alex**, Theater Projectionist, Valuskis Theatres. **Mail:** 11914 Cheshire St., Norwalk, Calif. (A)
- Gibbons, Thomas J., Jr.**, Sales Engineer, Minnesota Mining & Manufacturing Co. **Mail:** 909 Kingsley Dr., Arcadia, Calif. (M)
- Gordon, James B.**, Director of Photography and Head of Optical Printing Dept., 20th Century-Fox Film Corp. **Mail:** 2225 Linnington Ave., Los Angeles 64, Calif. (M)
- Graff, Lee**, Chief Engineer, Brenkert Light Projection Co. **Mail:** 4510 Lawre Rd., Centerline, Mich. (M)
- Heimbach, Newton**, Chemist, Assistant Film Plant Manager, Bell & Howell Co. **Mail:** 145 Commonwealth Rd., Rochester, N.Y. (M)
- Hoff, J. Robert**, Sales Manager, The Ballantyne Co. **Mail:** 1707 Davenport St., Omaha, Nebr. (M)
- Howard, Bruce**, Audio Facilities Engineering & Recording Supervisor, Radio Station WBAP, (AM-FM-TV). **Mail:** 2754-B Primrose, Fort Worth, Tex. (M)
- Huntsman, Harold F.**, Television Engineering Field Supervisor, KECA-TV. **Mail:** 409 Irving Ave., Glendale 1, Calif. (M)
- Hyll, Richard**, Laboratory Technician, Film Associates. **Mail:** 325 N. Main St., Bowling Green, Ohio. (A)
- Iwerks, Donald**, Assembly Dept., Photographic Products. **Mail:** 15153½ Dickens St., Sherman Oaks, Calif. (A)
- Jayne, Stuart T.**, Assistant Plant Engineer, Pathé Industries, Inc. **Mail:** 1259 N. Mansfield, Hollywood 38, Calif. (A)
- Johnson, Elisha H.**, School of Public Relations, Boston University. **Mail:** 177 Academy St., Jersey City 6, N.J. (S)
- Johnson, Stanley L.**, University of Southern California. **Mail:** 1041 Browning Blvd., Los Angeles 37, Calif. (S)
- Kotis, Arnold F. T.**, Free-Lance Cameraman. **Mail:** 39-37—49 St., Long Island City 4, N.Y. (A)
- Krause, Edward B.**, Manufacturer of Film Processing Equipment. **Mail:** 40 Birch Pl., Stratford, Conn. (M)
- Lawrence, Robert L.**, Eastern Manager, Jerry Fairbanks, Inc. **Mail:** 235 E. 73 St., New York 21, N.Y. (M)
- Mabuchi, Osamu**, Electronic Engineer, Chemist, Matsushita Electric Industrial Co., Ltd. **Mail:** 38 Shimamachi, Nishikujo Shimosyo-ku, Kyoto City, Japan. (A)

- Milwitt, William**, Engineer, RCA Laboratories. **Mail:** 620 S. Catalina St., Los Angeles 5, Calif. (A)
- Mueller, Gustave M.**, Supervisor, Machine Shop, Pathé Laboratories, Inc. **Mail:** 2913 Marsh St., Los Angeles 39, Calif. (A)
- Nebbia, Michael**, Free-Lance Cinematographer. **Mail:** 831 Lexington Ave., New York 21, N.Y. (A)
- Oertel, John T.**, Motion Picture Laboratory Technician, George W. Colburn Laboratory. **Mail:** 701 Willow St., Chicago 14, Ill. (A)
- Parker, Jackson G.**, Motion Picture Dept., University of California at Los Angeles. **Mail:** 476 Midvale, Los Angeles 24, Calif. (S)
- Plass, Joseph P.**, Photographer, National Institutes of Health, U.S. Public Health Service. **Mail:** 4701 MacArthur Blvd., N.W., Washington, D.C. (M)
- Racies, Larry**, Cameraman, Newsreel Service. **Mail:** 140 E. 46 St., New York 17, N.Y. (M)
- Richards, Balfour A.**, District Engineer, Palace Amusement Co., (1921) Ltd., P.O. Box 211, Kingston, Jamaica, British West Indies. (A)
- Riddle, William R.**, Television Film Editor, WOR-TV. **Mail:** 91 Central Park West, New York 23, N.Y. (A)
- Roberts, Paul M.**, New York University. **Mail:** 29 Wadsworth Ave., New York 33, N.Y. (S)
- Romans, William E.**, American Television Inst. **Mail:** 4030 N. Sheridan Rd., Chicago 13, Ill. (S)
- Schwarz, George**, Plant Manager, Rochester Film Div., Bell & Howell Co. **Mail:** 90 Browncroft Blvd., Rochester 9, N.Y. (M)
- Scott, David C.**, Producer. **Mail:** 636 Las Casas Ave., Pacific Palisades, Calif. (A)
- Seaman, Gerald**, Hollywood University. **Mail:** 1411½ N. Alexandria, Hollywood 27, Calif. (S)
- Shea, Robert P.**, Mechanical Engineer, Producers Service Co. **Mail:** 5447 Radford Ave., North Hollywood, Calif. (M)
- Sheldon, John L.**, Research Physicist, Corning Glass Works. **Mail:** 112 E. Third, Corning, N.Y. (M)
- Sinnett, Robert J.**, Chief Engineer, WHBF, AM/FM/TV, Rock Island Broadcasting Co. **Mail:** 3201 Twenty-Fifth St., Rock Island, Ill. (M)
- Spielvogel, Bert**, Motion Picture Cameraman, City of New York, WNYC-TV. **Mail:** 30 W. 105 St., New York 25, N.Y. (A)
- Swedlund, Lloyd E.**, Electrical Engineer, Radio Corporation of America, RCA Victor Division, Lancaster, Pa. (A)
- Tchakmakian, Krikor**, Sound Engineer, Nahas Studios, Pyramids Rd., Cairo, Egypt. (M)
- Thomas, Philip F.**, Test Engineer, Western Electric Co. **Mail:** 5400 Columbus Ave., Van Nuys, Calif. (A)
- Valentine, Christian, Jr.**, Art Director, Biow Co. **Mail:** 36-40 Bowne St., Flushing, N.Y. (A)
- Van der Wyk, Jack**, University of Southern California. **Mail:** 2739 Morningside St., Pasadena 8, Calif. (S)
- Volmar, Victor**, Publicity Director & Supervisor of Foreign Versions, Monogram International Corp. **Mail:** 55 Payson Ave., New York 34, N.Y. (A)
- Wade, Roger W.**, Photographer, Motion Picture Producer, Roger Wade Productions. **Mail:** 77-17 247 St., Bellerose, N.Y. (M)
- Weiss, Harry Allan**, Sound Technician, Ryder 16-Mm Services. **Mail:** 6126 Orange St., Los Angeles 48, Calif. (A)
- White, Lyman R.**, University of Southern California. **Mail:** 1066 W. 34 St., Los Angeles 7, Calif. (S)

CHANGES IN GRADE

- Calhoun, John M.**, Chemist, Dept. of Manufacturing Experiments, Kodak Park, Eastman Kodak Co., Rochester, N.Y. (M) to (A)
- Jamgochian, Matthew**, Teacher, Los Angeles City Schools. **Mail:** 318 Road's End, Glendale 5, Calif. (S) to (A)
- Law, Edgar**, Chief Re-Recording Engineer, British Lion Studio Co., London Films Studio, Shepperton, Middlesex, England. **Mail:** 19 Delta Rd., Worcester Park, Surrey, England. (M) to (A)
- Shapiro, Melvin**, Editor, Projectionist, Production Assistant, Ryder 16-Mm Services. **Mail:** 823 N. Genesee, Los Angeles 46, Calif. (S) to (A)
- Somes, George W.**, Sound Recording Technician, U.S. Navy Electronics Laboratory. **Mail:** 1247 Savoy St., San Diego 7, Calif. (A) to (M)
- Willis, John B.**, Free-Lance Cameraman. **Mail:** Box 1567, Grand Coulee, Wash. (S) to (A)

DECEASED

- Brake, Alan R.**, 143 S. Robertson Blvd., Los Angeles 3, Calif. (A)
- Paoliello, Vincent**, Field Engineer, Capitol Motion Picture Supply Corp., 630 Ninth Ave., New York (A)

BOOK REVIEWS

The Great Audience

By Gilbert Seldes. Published (1950) by Viking Press, 18 E. 48 St., New York 17. 229 pp. 5½ × 8½ in. Price \$3.75.

Twenty-five years ago Gilbert Seldes in *The Seven Lively Arts* presented the then daring proposition that the popular arts—movies, radio, comic strips, vaudeville, etc.—should be assessed by the same critical standards which apply to the fine arts. He contended that the influence of such widely popular artists as Chaplin, Gershwin or Herriman merited serious esthetic consideration. Now, in his latest work, *The Great Audience*, he has reassessed the position of the mass arts and resituated them in a larger social frame of reference, feeling that, while their relation to the fine arts is now secure, the dominant mass entertainments—radio, movies and television—have taken on an additional significance as media of mass communication.

To his task Mr. Seldes brings an unusual combination of qualifications—a lively and sympathetic affection for the popular arts, bolstered by wide practical experience in television, radio and the movies, together with an incisive critical temper unencumbered by political or intellectual prejudices. Out of the tremendous upheaval and chaos resulting from the relocations now taking place in the entertainment field he has not only grasped and clearly analyzed the significant organizational and distribution problems, but has also offered reasonable proposals for reorganization of our existing political and economic framework.

He recognizes that the popular arts have certain characteristics which set them off from the fine arts, notably the fact that they are not made for the ages, but created to be quickly enjoyed and forgotten.

In his analyses of present-day conditions in the movie industry, Seldes proposes reorganization of the industry to meet the threats of television and diminishing box office receipts. He upsets many widely touted beliefs of the movie industry, such as "Nearly everyone goes to the movies," "the movie industry is the fourth largest in the U.S.," and that most of the profits

of the industry come from production and releasing of movies. He points out that the manufacture of motion pictures actually ranks about forty-sixth, that the great bulk of movie profits comes from distribution and exhibition rather than from manufacturing, and that public opinion polls made for the industry have indicated many startling facts as to who actually goes to the movies today. The great majority of those who go to the movies today are under twenty years of age. After twenty-five, people gradually stop going to movies geared to adolescent tastes. Between thirty and forty, more than half the population of the U.S. does not go to the movies more than once a month, while after fifty half the population never goes at all. Thus the claimed eighty million paid attendances a week actually represent between thirteen and fifteen million individuals.

Movie manufacturers, faced by the loss of overseas markets, the inroads on a joint audience by television, and the enforced separation of manufacturing and exhibition facilities under antitrust regulations, find themselves in a precarious position. Part of the trouble lies in the standardized movie product itself, which Seldes claims has degenerated from the telling of a story to being the embodiment of a popular mythology gauged for the taste of the perennially adolescent movie audience, itself predicated on a fixed rate of birth and age turnover. Seldes proposes that the movies try to recapture their lost audiences by production of more varied and mature films and by increasing secondary channels of distribution for them along the lines of the "art" (or "sure seater") theater and the now vanished newsreel theater circuits. The financial success of "Hamlet" has proved that even a serious "class" film can, with proper exploitation and distribution, provide adult movie fare and at the same time make money.

In the competition of movies and television for the same mass audience, Seldes presumes three courses of action: (1) a merger of interests whereby the movie producers could make special films for television and movies for their own theaters, and use the latter for showing both films

and television features, (2) *compromise*—Hollywood may become a special manufacturing unit for television, at the same time making films for more mature and specialized movie audiences, (3) *active competition*—the movie industry might concentrate on action films, westerns and Technicolor musical extravaganzas where television cannot successfully compete.

Seldes believes television can be most effective in straight dramatic productions, where the artificial is immediately obvious and out of place, as well as in its presentation of sports and vaudeville. By combining live news events and newsreel film a unique documentary form might be developed. In an effective reorientation of the popular arts, television may capture the mass audience by presenting sports and vaudeville, radio may survive by presenting documentary, cultural and musical features, and movies by concentrating on the production of fiction and extravaganzas.

Provocative, thoughtful and well documented, *The Great Audience* is surely one of the most intelligent and searching examinations of the popular arts to appear in many years, significant for the industrial specialist and the general reader alike. To Seldes, the popular arts are of enormous significance in the culture of a democracy, and their development and control should be the concern of every citizen, since we are all in some degree affected by them whether we are aware of it or not.—THOMAS BARRY HUNT, 752 Greenwich St., New York 14.

Movies for TV

By John H. Battison. Published (1950) by Macmillan, 60 Fifth Ave., New York. 376 pp. + numerous illus. $5\frac{3}{4} \times 8\frac{1}{2}$ in. Price \$4.25.

The recent growth of television has provided employment for many new people who find themselves in an unfamiliar world. Also, many old hands in advertising and the theater feel the lack of basic information on a new art and science. It is to these people that this book is directed.

To quote the jacket, "This book . . . provides information both on technical equipment and on program planning, needed to insure the best results from

movies on television, including a great deal of experienced advice on technical and artistic details which may cause trouble."

On page 128 the author says, "But the reader of this book will not normally be expected to have much to do with the technical side." And on page 246, "This book is not intended to produce engineers, producers, or even technicians, but after reading and studying it the reader should be well prepared for any job in the film department of a television station that does not require specialized technical knowledge. It should be equally helpful to anyone else who is concerned with films for television."

Obviously any single book which treats such a wide variety of subjects must touch upon each rather lightly. But for the person who wishes to gain a quick broad view of these subjects, Mr. Battison presents it with an easily read seminarrative style that is clear and pleasing.—C. L. TOWNSEND, National Broadcasting Co., 30 Rockefeller Plaza, New York.

Preparation and Use of Audio-Visual Aids

By Kenneth B. Haas and Harry Q. Packer. Published (1950) by Prentice-Hall, Inc., 70 Fifth Ave., New York 11. i-xii + 327 pp. including 36 pp. appendix and 7 pp. index. Profusely illus. 6×9 in. Price \$4.65.

This is the second edition of a well-known textbook. The first edition was "aimed at industrial and store personnel trainers." In this revision the authors attempted to broaden its appeal and usefulness, but much of the original plans remains.

The authors have compressed into a relatively few pages an enormous amount of information about every type of audio-visual aid. The book contains many lists of criteria for materials and rules on utilization of them. Although the authors keep the viewpoint intensely topical and devote very little space to theoretical considerations such as the psychology behind the use of audio-visual materials, the book is so complete that it constitutes a reference work in the field. All of the well-known instructional aids and some of the less well known are included. Two of the best

chapters are on using the blackboard and on setting up and operating an audio-visual laboratory. The chapter on the laboratory will be especially useful to schools of education. The authors have made good use of line drawings to enliven the text. Since the illustrations are so good it is surprising to find no examples of charts, such as pie charts and bar graphs.

The book is so full of ideas and hundreds of practical suggestions that the compression necessary to get these into a small

space has resulted in some subjects being slighted. It is impossible, obviously, to explain photography in two or three pages or outline objective research methods in one page. This book, therefore, is not a thorough discussion of any one phase of audio-visual education but is an overview of the whole subject. There is an appendix on sources of materials and equipment.—PAUL R. WENDT, College of Education, University of Minnesota, Minneapolis 14.

Current Literature

THE EDITORS present for convenient reference a list of articles dealing with subjects cognate to motion picture engineering published in a number of selected journals. Photostatic or microfilm copies of articles in magazines that are available may be obtained from The Library of Congress, Washington, D.C., or from the New York Public Library, New York, N.Y., at prevailing rates.

American Cinematographer

vol. 31, no. 10, Oct. 1950
Choosing a 16Mm Camera for Professional Work (p. 342) L. ALLEN
New Technicolor System Announced (p. 354)

vol. 31, no. 11, Nov. 1950
Economy Prime Factor in Producing Films for TV (p. 377) H. A. LIGHTMAN
Advantages of Variable Shutters in 16Mm Cine Photography (p. 386) J. FORBES

vol. 31, no. 12, Dec. 1950
New Technicolor System Tested by Directors of Photography (p. 414) L. ALLEN
Surgical Cinematography (p. 417) F. C. ELLIS
New Camera and Tripod Carrier Developed at MGM (p. 418) F. FOSTER

British Kinematography

vol. 16, no. 4, Apr. 1950
Technical Requirements of a Mobile Studio Unit for Feature Films (p. 109) B. HONRI
Modern Kinema Equipment: III., Accessory Equipment and Film Mutation (p. 122) R. A. RIGBY
Improvements in Large-Screen Television (p. 126) T. M. C. LANCE

vol. 16, no. 5, May 1950
Maintenance of 16Mm Print Quality
I. The Renter's Problems (p. 152) E. F. BRADLEY
II. Problems in the Field (p. 154) M. RAYMOND, JR.

vol. 16, no. 6, June 1950
High-Diffusion Screens for Process Projection (p. 189) H. McG. ROSS

vol. 17, no. 2, Aug. 1950
Science and the Motion Picture (p. 42) R. WATSON-WATT
The Evolution of the Newsreel
I. Introduction (p. 47) H. THOMAS
II. The Early Days of Newsreels (p. 47) K. GORDON
III. The Development of the Sound Newsreel (p. 50) W. S. BLAND
IV. The Future of the Newsreel (p. 53) H. THOMAS
History and Development of the Colour Film (p. 57) R. H. CRICKS

vol. 17, no. 3, Sept. 1950
Electrical Devices as Applied to Special Effects
I. Problems of Remote Control (p. 84) J. GOW
II. Miscellaneous Equipment (p. 85) F. GEORGE

Electronics

vol. 23, no. 8, Aug. 1950
Improved Deflection and Focus (p. 94) C. V. BOCCIARELLI

vol. 23, no. 12, Dec. 1950
Color Fundamentals for TV Engineers (p. 88) D. G. FINK

vol. 24, no. 1, Jan. 1951
Color Fundamentals for TV Engineers, Pt. II (p. 78) D. G. FINK

Illuminating Engineering

vol. 45, no. 10, Oct. 1950
Television Studio Illumination (p. 606) H.
M. GURIN and R. L. ZAHOUR

International Photographer

vol. 22, no. 11, Nov. 1950
Color of Illumination (p. 5) D. NORWOOD
More About "Inspacian" (p. 8) I. M.
TERWILLIGER

vol. 22, no. 12, Dec. 1950
TV Newsreel Production Technique (p. 5)
J. SANDSTONE
Smallest TV Camera (p. 8) A. L. MARBLE

International Projectionist

vol. 25, no. 7, July 1950
Notes on Modern Projector Design, Pt.
III (p. 5) R. A. MITCHELL
The Ventarc H. I. Carbon 'Blown' Arc: A
New Concept (p. 13) E. GRETERER

vol. 25, no. 10, Oct. 1950
L-1 Arcs: Horse and Buggy Projection
(p. 5)

Process Projection of Film for TV (p. 8)
R. A. LYNN and E. P. BERTERO
Projection Shutters: A Symposium (p. 11)
R. H. CRICKS
The Projection of Safety Film (p. 21) R.
A. MITCHELL

vol. 25, no. 11, Nov. 1950
Cinerama: Super-Movies of the Future
(p. 10)

Motion Picture Herald

(Better Theatres), vol. 182, Jan. 6, 1951
"Videofilm" Theatre TV System Using
16Mm Stock in Production (p. 37)
All-Plastic Screen in Radio City Music
Hall (p. 38)

Radio & Television News

vol. 45, no. 1, Jan. 1951
Servicing the 16Mm Sound Projector (p.
36) D. D. EMERSON

Tele-Tech

vol. 9, no. 10, Oct. 1950
The FCC Color TV Decision (p. 26)

vol. 9, no. 11, Nov. 1950
Video Recordings Improved by the Use of
Continuously Moving Film (p. 32) W.
D. KEMP

vol. 9, no. 12, Dec. 1950
Approaches to Color TV (p. 44) J. H.
BATTISON

High Definition Monochrome TV (p. 52)
F. LOOMIS
A New Video Distribution System (p. 28)
E. D. HILBURN

Tele-Vision Engineering

vol. 1, no. 10, Oct. 1950
Subtractive Color TV (p. 12) I. KAMEN
Video Special-Effects System (p. 14) E. M.
GORE

vol. 1, no. 12, Dec. 1950
Metal-Backed TV Picture Tubes (p. 12)
C. T. WAUGH

Society Awards for 1951

THERE ARE NOW SIX formal Society Awards which are available for presentation annually to industry engineers who meet the qualifications briefly stated here.

Detailed reports of qualifications of all previous recipients of three of the awards are presented on pp. 641-643 of the JOURNAL for May, 1950, and illustrations showing both sides of two of the Society's medals appear on pp. 476-477 of the April, 1949, JOURNAL. Suggestions for possible candidates to be considered by the several award committees may be sent to

Society Headquarters or addressed directly to the individual chairmen.

FELLOW AWARD

Members in the Active grade who by their "... proficiency and contributions have attained outstanding rank among engineers or executives of the motion picture industry" may be proposed and considered as possible award nominees by the Fellow Award Committee. Such proposals will be received only from present Fellows of the Society and should be addressed to

Chairman, Earl I. Sponable, Fox Movietone, Inc., 460 West 54th Street, New York 19, N. Y.

HONORARY

The Honorary Membership Award is a distinction given to pioneers who have contributed inventions of basic importance to the industry or whose contributions have made possible better production, administration or utilization of motion pictures. Recommendations for the Honorary Membership Award may be submitted by any member of the Society and must be endorsed by at least five Fellows, who are required to set forth in writing their knowledge of the accomplishments which appear to justify presentation of the Award. Such recommendations must be addressed to the Honorary Membership Committee Chairman, Gordon A. Chambers, Motion Picture Film Dept., Eastman Kodak Company, 343 State St., Rochester 4, N. Y.

JOURNAL AWARD

The Journal Award is presented annually at the Fall Convention of the Society to the author of the most outstanding paper originally published in the JOURNAL of the Society during the preceding calendar year. Technical merit, originality and excellence of presentation are three major considerations. The authors of papers of nearly equivalent merit often receive Honorable Mention. The Journal Award Committee, appointed by the President is now under the Chairmanship of Mr. Paul Arnold, who will shortly be receiving from members of his Committee, their recommendations for the most outstanding paper for 1950. His address is: Ansco Corp., Binghamton, N. Y.

SAMUEL L. WARNER MEMORIAL AWARD

Each year the President appoints a Samuel L. Warner Memorial Award Committee to consider candidates for the Award. Preference is given to inventions or developments occurring in the last five years, and also to inventions or developments likely to have the widest and most beneficial effect on the quality of reproduced sound and picture. The Award is

made to an individual and may be based upon his contributions of the basic idea involved in the particular development being considered and also on his contributions toward the practical working out of the idea. The purpose of the Award is to encourage the development of new and improved methods or apparatus designed for sound on film motion pictures, including any step in the process. The present Chairman of the Committee is Glenn L. Dimmick, RCA Victor Division, Bldg. 10-4, Camden, N. J.

PROGRESS MEDAL AWARD

Written recommendations for candidates for the Progress Medal Award may be submitted by any member of the Society, giving in detail the accomplishments which appear to justify consideration. Qualifications should include invention, research, or development which has resulted in a significant advance in the development of motion picture technology and should be seconded in writing by any two Fellows or Active members of the Society, after which the recommendations must be filed with the Chairman of the Committee. For 1951, the Chairman is D. B. Joy, National Carbon Div., Union Carbide and Carbon Co., 30 E. 42 St., New York 17.

DAVID SARNOFF GOLD MEDAL

Most recent of the Society Awards is the David Sarnoff Gold Medal, offered by the Radio Corporation of America to a recipient to be selected by a committee appointed annually by the President of the Society. It will be presented annually at the Fall Convention to an individual "who has done outstanding work in some technical phase of the broad field of television or in any similar phase of theater television, whether in research, development, design, manufacture or operation."

The award will consist of a gold medal, a bronze replica and a certificate which states the accomplishments which justify its presentation. Its objective is "to encourage the development of new techniques, new methods and new equipment which hold promise for the continued improvement of television."

New Products

Further information about these items can be obtained directly from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of news items does not constitute an endorsement.

The Johnson Kam-Lok is designed to enable a camera to be quickly attached to or detached from a tripod. The two parts which fit together are released by pulling the chain attached to the spring-loaded locking pin. The top portion is screwed into the tripod bush of the camera and can be left there. The lower part is screwed onto the tripod. It is suited to small movie cameras as well as still cameras. The Johnson Kam-Lok is distributed by General Photographic Supply Co., 136 Charles St., Boston 14, Mass.



An Underwater exposure meter has been developed by Fenjohn Underwater Photo & Equipment Co., 90 Cricket Ave., Ardmore, Pa. A Weston Model 852 exposure meter has been enclosed in a watertight, light-weight, cast-aluminum case. Designed for use in subsurface photography and in tropical atmosphere, it weighs in air 16 oz and is $3 \times 4 \times 1\frac{1}{2}$ in. It is priced at \$168.00 including Federal tax.

A Control Track Generator, for synchronous recording with a tape recorder already in use, has been designed by, and is available from, Fairchild Recording Equipment Corp., 154 St. and 7th Ave., Whitestone, N.Y. Called Fairchild Unit 140, the cost is \$335.00 f.o.b. Whitestone. It will extend the functions of the tape recorders which are performing within the specifications published as the NAB Primary Standard, so that such recorders may meet operational requirements of the film and television industries. The con-

trol track signal is mixed with the program signal so that both are simultaneously recorded. When played back on the manufacturer's Pic-Sync reproducer, the recorded program is synchronous with the frequency of the power line which supplied the original recorder and is therefore in "sync" with any other equipment operating from the same line at the same time.

1950 Radiofile Annual is the fifth yearly annual now available from the publisher, Richard H. Dorf, 255 W. 84 St., New York 24. Radiofile is a bimonthly publication which indexes and cross-indexes by subject all articles of technical interest in 15 leading American radio and television magazines and journals, which includes the JOURNAL. The sixth Radiofile for a year represents all items indexed for that year, for the index is cumulative. The 1950 Radiofile Annual is sold for \$0.50, and a regular yearly subscription to Radiofile is \$2.00.

SMPTE Officers and Committees: The Roster of Society Officers was published in the May 1950 JOURNAL. For Administrative Committees see pp. 515-518 of the April 1950 JOURNAL. The most recent roster of Engineering Committees appeared on pp. 337-340 of September 1950 JOURNAL.



Bruno E. Stechbart

AFTER 37 YEARS of designing precise mechanisms for the motion picture industries, Bruno E. Stechbart resigned from active work with the Bell & Howell Co. He joined Bell & Howell in 1927 as Development Engineer, became Assistant Chief Engineer in 1929 and ten years later, when A. S. Howell, one of the Company's founders and its Technical Director from the beginning, retired, he became the Chief Engineer. He was elected Vice-President in Charge of Engineering in 1944 and held that position until July 18, 1950, his 60th birthday and the official date of his retirement.

His application for membership in the Society was dated August 8, 1921. At that time, he was Chief Engineer of the American Projecting Co. in Chicago. In 1929, the Society elevated him to the grade of Fellow.

Mr. Stechbart was born in Lode, Russia, (later Poland and Germany), on July 18, 1890. He came to the United States in 1906 and, having both interest and aptitude along mechanical lines, found regular work in machine shops. To round out his knowledge, he studied during off hours and at night. In 1913, he became so interested in a 35-mm combination camera-projector venture that he decided to cast his lot permanently with the camera apparatus end of the then-growing motion picture industry. After a period of experimentation, he developed a 35-mm projector, the Projectoscope, which was taken up by the American Projectoscope Co., a subsidiary of the American Film Company. He was then employed by them for a period of six years. In 1926, he joined the De Vry Corporation as Chief Engineer, leaving there a year later to become a Development Engineer at Bell & Howell.

Among his former associates, he is known for his engineering skill and meticulous attention to details of design. The products developed under his guidance present adequate corroboration as does the technical article "The Bell & Howell Fully Automatic Sound Picture Production Printer" that appeared in the JOURNAL for October, 1932. He was coauthor with A. S. Howell and R. F. Mitchell. At the present time, he holds 46 patents and has several applications pending.

Now, in retirement, Mr. and Mrs. Stechbart have moved from Chicago to 206—49th Street West, R. D. No. 1, Bradenton, Fla.

Meetings of Other Societies

American Physical Society, Apr. 26-28, Washington, D.C.

Acoustical Society of America, May 10-12, Washington, D.C.

American Physical Society, June 14-16, Schenectady, N.Y.

American Physical Society, June 25-28, Vancouver, Canada

American Institute of Electrical Engineers, June 25-29, Toronto, Canada

Biological Photographic Association, 21st Annual Meeting, Sept. 12-14, Kenmore Hotel, Boston, Mass.

Society of Motion Picture and Television Engineers

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